ALAGAPPA UNIVERSITY

[Accredited with 'A+' Grade by NAAC (CGPA:3.64) in the Third Cycle
and Graded as Category–I University by MHRD-UGC]

(A State University Established by the Government of Tamil Nadu)

KARAIKUDI – 630 003

Directorate of Distance Education

B.B.A.

IV - Semester

104 43 / 126 43

RESEARCH METHODS

Reviewer	

Authors:

Naseem Abidi, *Associate Professor, Jaypee Business School, Jaypee Institute of Information Technology, Noida*
Units: (1.0-1.2, 1.3-1.8, 3.3-3.10, 5, 6.2-6.2.1)

Dr. Deepak Chawla, *Distinguished Professor, Dean (Research & Fellow Programme), International Management Institute (IMI), New Delhi*
Dr. Neena Sondhi, *Professor, International Management Institute (IMI), New Delhi*
Units: (1.2.1, 2, 3.0-3.2, 6.0-6.1, 6.2.2-6.8, 7, 10.2.1, 12.0-12.2, 12.3-12.3.1, 13.0-13.1, 13.2.2-13.3.4, 13.5-13.9)

Vikas® Publishing House, Units: (4, 8, 9, 10.0-10.2, 10.3-10.10, 11, 12.2.1, 12.3.2-12.10, 13.2-13.2.1, 13.4-13.4.1, 14)

VIKAS® PUBLISHING HOUSE PVT. LTD.
E-28, Sector-8, Noida - 201301 (UP)
Phone: 0120-4078900 • Fax: 0120-4078999
Regd. Office: A-27, 2nd Floor, Mohan Co-operative Industrial Estate, New Delhi 1100 44
• Website: www.vikaspublishing.com • Email: helpline@vikaspublishing.com

Work Order No. AU/DDE/DE12-01/Preparation and Printing of Course Materials/2020 Dated 30.01.2020 Copies - 600

SYLLABI-BOOK MAPPING TABLE

Research Methods

Syllabi	Mapping in Book
BLOCK I: FUNDAMENTALS OF RESEARCH	
Unit - 1: Meaning, Types and Process of Research: Meaning - Purpose - Types of Research	**Unit 1:** Meaning, Types and Process of Research **(Pages 1-14);**
Unit - 2: Pure & Applied, Historical & Futuristic, Analytical & Synthetic, Descriptive & Prescriptive, Survey & Experimental and Case & Generic Researches	**Unit 2:** Different Types of Research and Advancements **(Pages 15-30);**
Unit - 3: Significance of research in social sciences - Process of research - Meaning - Scientific method - Induction and deduction.	**Unit 3:** Significance of Research **(Pages 31-50);**
Unit - 4: Planning Research: Research problem - Identification, selection and formulation of research problem - Review of literature in the field of business	**Unit 4:** Planning Research **(Pages 51-65)**
BLOCK II: SAMPLING AND ITS TYPES	
Unit - 5: Economic management: Use in identifying Research Gaps and Techniques - Hypothesis - Meaning - Sources and Types of Hypothesis - Hypothesis Formulation for testing - Research design - Factors affecting research design - Evaluation of research design.	**Unit 5:** Economic Management **(Pages 66-81);**
Unit - 6: Sampling Design: Census method and sampling method for investigation - Principle of sampling - Essentials of a good sampling - Methods of sampling	**Unit 6:** Sampling Design **(Pages 82-90);**
Unit - 7: Probability and non-probability sampling methods - Sample size - Factors affecting the size of the sample - Biased sample - Sampling and non-sampling errors.	**Unit 7:** Probability and Non-Probability Sampling Methods, Sample Size and Sampling and Non-sampling Errors **(Pages 91-114);**
Unit - 8: Sources and Collection of Data: Sources of data - Primary and secondary data - Modes of data collection - Observation: Types and Techniques -Interview: Types and conduct - Preparation for an interview - Effective interview techniques - Limitations of interview	**Unit 8:** Sources and Collection of Data-I **(Pages 115-125)**
BLOCK III: TOOLS OF DATA COLLECTION	
Unit - 9: Schedule: Meaning and kinds - Essentials of a good schedule - Procedure for the formulation of a schedule - Questionnaire: Meaning and types - Format of a good questionnaire- Schedules vis-a-vis Questionnaires	**Unit 9:** Sources and Collection of Data-II **(Pages 126-141);**
Unit - 10: Scaling techniques: Meaning, Importance, Methods of their construction of Questionnaires or Schedules - Pre-testing of Data Collection Tools- Validity and Reliability - Methods.	**Unit 10:** Sources and Collection of Data-III **(Pages 142-172);**
Unit - 11: Processing and Analysis of Data: Meaning - Importance - Process of data analysis - Editing - Coding - Tabulation - Diagrams - Univariate, Bivariate and Multi-variate analyses	**Unit 11:** Processing and Analysis of Data **(Pages 173-189)**
BLOCK IV: HYPOTHESIS AND REPORT WRITING	
Unit - 12: Test of Hypothesis: Fundamentals on Test Procedure- Testing for significance of Mean/Proportion and difference between Means/Proportions- F Test for Means and Chi-square test Contingency Table	**Unit 12:** Test of Hypothesis **(Pages 190-213);**
Unit - 13: Concept and Types of Non-parametric Texts- Mann Whitney Test- The process of interpretation of Test Results- Guidelines for making valid interpretation.	**Unit 13:** Overview of Non-Parametric Tests **(Pages 214-237);**
Unit - 14: Report Writing : Role and types of reports - Contents of research report - Steps involved in drafting reports - Principles of good report writing - Grammatical Quality - Language flow- Data Support- Diagrammatic Elucidation- References and Annotations - Clarity and Brevity of expressions- Features of a good Report- Criteria for evaluating research reports/ research findings.	**Unit 14:** Report Writing **(Pages 238-268)**

CONTENTS

INTRODUCTION

BLOCK I: FUNDAMENTALS OF RESEARCH

UNIT 1 MEANING, TYPES AND PROCESS OF RESEARCH 1-14

1.0 Introduction
1.1 Objectives
1.2 Definition and Meaning of Business Research
 1.2.1 Applications of Business Research
1.3 Types of Research
1.4 Answers to Check Your Progress Questions
1.5 Summary
1.6 Key Words
1.7 Self Assessment Questions and Exercises
1.8 Further Readings

UNIT 2 DIFFERENT TYPES OF RESEARCH AND ADVANCEMENTS 15-30

2.0 Introduction
2.1 Objectives
2.2 Recent Advancements in Research: Online Research
2.3 Distinction between Different Types of Researches
2.4 Answers to Check Your Progress Questions
2.5 Summary
2.6 Key Words
2.7 Self Assessment Questions and Exercises
2.8 Further Readings

UNIT 3 SIGNIFICANCE OF RESEARCH 31-50

3.0 Introduction
3.1 Objectives
3.2 Constructing Hypothesis
 3.2.1 Identifying Variables
 3.2.2 Characteristics and Functions
 3.2.3 Types of Hypotheses
3.3 Significance of Research in Social Sciences
3.4 Scientific Method: Induction and Deduction
3.5 Process of Research
3.6 Answers to Check Your Progress Questions
3.7 Summary
3.8 Key Words
3.9 Self Assessment Questions and Exercises
3.10 Further Readings

UNIT 4 PLANNING RESEARCH 51-65

4.0 Introduction
4.1 Objectives
4.2 Research Problem
 4.2.1 Identification, Selection and Formulation of Research Problem
 4.2.2 Identification of Objectives of the Research

4.2.3 Statement of Research Problem and Cost and Value Information
4.3 Review of Literature in the Field of Business
4.4 Answers to Check Your Progress Questions
4.5 Summary
4.6 Key Words
4.7 Self Assessment Questions and Exercises
4.8 Further Readings

BLOCK II: SAMPLING AND ITS TYPES

UNIT 5 ECONOMIC MANAGEMENT 66-81

5.0 Introduction
5.1 Objectives
5.2 Use in Identifying Research Gaps and Techniques
5.3 Hypothesis: Meaning, Sources, Types of Hypothesis, and Hypothesis Testing
5.4 Research Design
5.4.1 Factors Affecting Research Design
5.4.2 Evaluation of Research Design
5.5 Answers to Check Your Progress Questions
5.6 Summary
5.7 Key Words
5.8 Self Assessment Questions and Exercises
5.9 Further Readings

UNIT 6 SAMPLING DESIGN 82-90

6.0 Introduction
6.1 Objectives
6.2 Meaning of Sampling Design
6.2.1 Principle of Sampling and Essentials of Good Sampling
6.2.2 Sampling Concepts and Sampling Frame
6.3 Census Method and Sampling Method for Investigation
6.4 Answers to Check Your Progress Questions
6.5 Summary
6.6 Key Words
6.7 Self Assessment Questions and Exercises
6.8 Further Readings

UNIT 7 PROBABILITY AND NON-PROBABILITY SAMPLING METHODS, SAMPLE SIZE AND SAMPLING AND NON-SAMPLING ERRORS 91-114

7.0 Introduction
7.1 Objectives
7.2 Methods of Sampling: Probability, Non-Probility and Mixed Sampling Design (or Systematic Sampling)
7.3 Sample Size Determination, Calculation and Factors Affecting the Size of the Sample
7.4 Sampling and Non-Sampling Errors
7.4.1 Biased Sample
7.5 Answers to Check Your Progress Questions
7.6 Summary
7.7 Key Words
7.8 Self Assessment Questions and Exercises
7.9 Further Readings

UNIT 8 SOURCES AND COLLECTION OF DATA-I 115-125

8.0 Introduction
8.1 Objectives

8.2 Sources of Data: Primary Data and Secondary Data
8.3 Modes of Data Collection
8.3.1 Interview: Types, Conduct, Preparation, Effective Techniques and Limitation
8.3.2 Observation: Types and Techniques
8.4 Answers to Check Your Progress Questions
8.5 Summary
8.6 Key Words
8.7 Self Assessment Questions and Exercises
8.8 Further Readings

BLOCK III: TOOLS OF DATA COLLECTION

UNIT 9 SOURCES AND COLLECTION OF DATA-II 126-141

9.0 Introduction
9.1 Objectives
9.2 Schedule: Meaning, Kinds, Essentials, Procedure for the Formulation of a Schedule
9.2.1 Schedules Vs. Questionnaires
9.3 Questionnaire: Meaning, Types and Format of a Good Questionnaire
9.4 Answers to Check Your Progress Questions
9.5 Summary
9.6 Key Words
9.7 Self Assessment Questions and Exercises
9.8 Further Readings

UNIT 10 SOURCES AND COLLECTION OF DATA-III 142-172

10.0 Introduction
10.1 Objectives
10.2 Scaling Techniques: Meaning, Importance, and Classification
10.2.1 Types of Measurement Scales: Nominal, Ordinal, Interval and Ratio
10.3 Methods of Construction of Questionnaires or Schedules
10.4 Pre-Testing of Data Collection Tools
10.5 Validity and Reliability Methods
10.6 Answers to Check Your Progress Questions
10.7 Summary
10.8 Key Words
10.9 Self Assessment Questions and Exercises
10.10 Further Readings

UNIT 11 PROCESSING AND ANALYSIS OF DATA 173-189

11.0 Introduction
11.1 Objectives
11.2 Meaning, Importance and Process of Data Analysis: Editing, Coding, Tabulation and Diagrams
11.3 Types of Analysis
11.4 Answers to Check Your Progress Questions
11.5 Summary
11.6 Key Words
11.7 Self Assessment Questions and Exercises
11.8 Further Readings

BLOCK IV: HYPOTHESIS AND REPORT WRITING

UNIT 12 TEST OF HYPOTHESIS 190-213

12.0 Introduction
12.1 Objectives

12.2 Fundamentals of Test Procedure
12.2.1 Types of Hypothesis Testing
12.3 Parametric Tests
12.3.1 Tests Concerning Means in Case of Single and Two Population Means- Z-test
12.3.2 Hypothesis Testing for Comparing Two Related Terms: T-test
12.3.3 Hypothesis Testing of Proportions, Difference between Proportions and Comparing Variance
12.3.4 Testing the Equality of Variances of Two Normal Populations: F-test
12.4 Statistical Techniques of Hypothesis Testing
12.5 Chi-Square Test and Contingency Table
12.6 Answers to Check Your Progress Questions
12.7 Summary
12.8 Key Words
12.9 Self Assessment Questions and Exercises
12.10 Further Readings

UNIT 13 OVERVIEW OF NON-PARAMETRIC TESTS 214-237

13.0 Introduction
13.1 Objectives
13.2 Non-Parametric Test: Concept and Types
13.2.1 Mann-Whitney Test
13.2.2 Kruskal Wallis
13.2.3 Sign Test
13.3 Multivariate Analysis
13.3.1 Factor Analysis
13.3.2 Cluster
13.3.3 Multidimensional Scaling (MDS)
13.3.4 Discriminant Analysis
13.4 The Process of Interpretation of Test Results
13.4.1 Guidelines for Making Valid Interpretation
13.5 Answers to Check Your Progress Questions
13.6 Summary
13.7 Key Words
13.8 Self Assessment Questions and Exercises
13.9 Further Readings

UNIT 14 REPORT WRITING 238-268

14.0 Introduction
14.1 Objectives
14.2 Role and Types of Research Reports
14.3 Steps Involved in Drafting Research Reports
14.4 Contents of Research Report
14.5 Report Writing: Principles, Features and Criteria
14.5.1 Principles of a Good Report Writing
14.5.2 Features of a Good Research Report
14.5.3 Criteria for Evaluating Research Reports/Research Findings
14.6 Research Report: Language Flow and Grammatical Quality
14.6.1 Clarity and Brevity of Expressions
14.6.2 References and Annotations
14.7 Data Support and Diagrammatic Elucidation
14.8 Answers to Check Your Progress Questions
14.9 Summary
14.10 Key Words
14.11 Self Assessment Questions and Exercises
14.12 Further Readings

INTRODUCTION

NOTES

Research is the quest for knowledge or a systematic investigation in order to establish facts. It helps to solve problems and to increase knowledge. The basic aim of research is to discover, interpret and develop methods and systems to advance human knowledge on diverse scientific matters. There are different types of research, such as exploratory, descriptive and experimental. Exploratory research is done when few or no previous studies of the subject exist. Descriptive research is used to classify and identify the characteristics of a subject. Experimental research suggests or explains why or how something happens. Thus, one of the primary aims of research is to explain new phenomena and generate new knowledge. Before conducting any research, a specific approach is to be decided; this is called research methodology. Research methodology refers to the way research can be conducted. It is also known as the process of collecting data for various research projects and helps to understand both the products as well as the process of scientific enquiry. A research process involves selection and formulation of a research problem, research design, sample strategy or sample design, as well as the interpretation and preparation of research report.

A few important factors in research methodology include the validity and reliability of research data and the level of ethics. A job is considered half done if the data analysis is conducted improperly. Formulation of appropriate research questions and sampling probable or non-probable factors are followed by measurement using survey and scaling techniques. A research design is a systematic plan for collecting and utilizing data so that the desired information can be obtained with sufficient accuracy. Therefore, research design is the means of obtaining reliable, authentic and generalized data. Research methodology is a very important function in today's business environment. There are many new trends in research methodology through which an organization can function in this dynamic environment.

This book, *Research Methods*, has been designed keeping in mind the self-instruction mode (SIM) format and follows a simple pattern, wherein each unit of the book begins with the Introduction followed by the Objectives for the topic. The content is then presented in a simple and easy-to-understand manner, and is interspersed with Check Your Progress questions to reinforce the student's understanding of the topic. A list of Self-Assessment Questions and Exercises is also provided at the end of each unit. The Summary and Key Words further act as useful tools for students and are meant for effective recapitulation of the text.

BLOCK - I

FUNDAMENTALS OF RESEARCH

NOTES

UNIT 1 MEANING, TYPES AND PROCESS OF RESEARCH

Structure

1.0 Introduction
1.1 Objectives
1.2 Definition and Meaning of Business Research
 1.2.1 Applications of Business Research
1.3 Types of Research
1.4 Answers to Check Your Progress Questions
1.5 Summary
1.6 Key Words
1.7 Self Assessment Questions and Exercises
1.8 Further Readings

1.0 INTRODUCTION

Broadly speaking, the search for knowledge is referred to as research. Research can also be defined as an art of scientific investigation. Within the academic scenario, research comprises defining and redefining problems, formulating hypothesis or suggested solutions; collecting, organising and evaluating data; making deductions and reaching conclusions; and in the end carefully testing the conclusions to determine whether they fit the formulating hypothesis. This unit will provide an overview of research. It will discuss the application and types of research. The process of research is also explained in this unit.

1.1 OBJECTIVES

After going through this unit, you will be able to:

- Define research
- Describe the application of research in various fields
- Explain the different types of research

1.2 DEFINITION AND MEANING OF BUSINESS RESEARCH

NOTES

A research generally begins with a question or a problem. The purpose of research is to find solutions through the application of systematic and scientific methods.

Meaning and Definitions

Research is a tool that is a building block and a sustaining pillar of every discipline—scientific or otherwise—that one knows of. Before comprehending the true meaning of the term, we would like to make it clear that this book primarily focuses on the process of business research. The premise of this decision-oriented enquiry is vast and may range from the simplistic view, which involves compilation and validation of information, to an exhaustive theory and model construction. To distinguish between non-scientific and scientific method, we would like to consider a few definitions of research.

One of the earliest distinctions was made by Lundberg (1942) who stated 'Scientific methods consist of systematic observation, classification, and interpretation of data. Now obviously, this process is one in which nearly all people engage in their daily life. The main difference between our day-to-day generalizations and the conclusions usually recognized as the scientific method lies in the degree of formality, rigorousness, verifiability, and general validity of the latter.'

Fred Kerlinger (1986) also validated the thought and stated that 'Scientific research is a systematic, controlled and critical investigation of propositions about various phenomena.' Grinnell (1993) has simplified the debate and stated 'The word *research* is composed of two syllables, *re* and *search*. The dictionary defines the former as a prefix meaning again, anew or over again and the latter as a verb meaning to examine closely and carefully, to test and try, or to probe. Together they form a noun describing a careful, systematic, patient study and investigation in some field of knowledge, undertaken to establish facts or principles.'

Thus, drawing from the common threads of the above definitions, we derive that management research is an unbiased, structured, and sequential method of enquiry, directed towards a clear implicit or explicit business objective. This enquiry might lead to validating existing postulates or arriving at new theories and models.

The most important and difficult task of a researcher is to be as objective and neutral as possible. The temptation to skew the results in the hypothesized direction has to be avoided at all costs. Magazine articles and newspaper surveys which want to prove a point might want to skew the opinion polls in favour of the Capitalists or the Republicans, or on the need for reservation

versus no reservation in educational institutes but a researcher has to collect and display the findings of the research as objectively as possible.

The last most important aspect of our definition that needs to be carefully considered is the decision-assisting nature of business research. Thus, as Easterby-Smith *et al.* (2002) state, business research must have some practical consequences, either immediately, when it is conducted for solving an immediate business problem or when the theory or model developed can be implemented and tested in a business setting. The world of business demands that managers and researchers work towards a goal—whether immediate or futuristic, else the research loses its significance in the field of management.

NOTES

Some of the proposed definitions of research are as follows:

- Redman and Mory have defined research as a systematized effort to gain knowledge.
- In the words of renowned researcher Clifford Woody, research involves defining and redefining problems; formulating suggested solutions or hypotheses; collecting, evaluating and organizing data, reaching conclusions and making deductions and carefully testing the conclusions to find out if they fit the formulating hypothesis or not.
- D. Slesinger and M. Stephenson in the *Encyclopaedia of Social Sciences* define research as the manipulation of things, concepts or symbols for the purpose of generalizing to extend, correct or verify knowledge, whether that knowledge aids in the construction of a theory or in the practice of an art.

Purpose of Research

The principal purpose of research is to find solutions to problems systematically. In general, the purpose of research can be specified as follows:

- To acquire familiarity with a phenomenon
- To study the frequency of connection or independence of any activity or occurrence
- To determine the characteristics of an individual or a group of activities and the frequency of the occurrence of these activities
- To test a hypothesis about a causal relationship that exists between variables

Characteristics of Research

The process of research helps increase the creative ability of a decision-maker. The various characteristics of research are as follows:

- **Interdisciplinary Team Approach**: This approach is based on the principle of using the expertise and experience of different personnel working in different disciplines within an organization. An individual cannot be an expert in all the areas of operation. So, researchers take help from other experts, who are specialists in their respective fields.

NOTES

Under interdisciplinary team approach, an expert may use old solutions, which are used in the past as a research material for finding the most appropriate solution to the problem.

- **Methodological Process**: Researchers use scientific methods and techniques to provide an optimum solution to the problems. The scientific methods include observing and defining a problem and formulating a hypothesis related to the results of the scientific methods and techniques. If the hypothesis is accepted, then its results should be executed in an organization, but if the hypothesis is not accepted, then another hypothesis is formulated.
- **Objectivistic Approach**: The aim of an organization is to provide optimal solutions to various problems. It is essential to measure the desirability of a solution for achieving the organizational objective. This measured desirability helps in comparing the alternative courses of action with respect to their outcomes.
- **Economical in Nature**: In an uncertain and complex situation, research helps in reducing the costs of inventory and thereby, improving the profits. For example, in inventory control, research can provide scientific rules for reducing acquisition costs and inventory-carrying costs.

Nature of Research

Good and effective research is identified by its nature, which signifies its focus on the research topic, a systematic way of implementation, control over the variables and so on. The nature of a good and effective research is as follows:

- **Objectivity:** A good research is objective in terms of offering solutions to the research questions. This calls for planning and creation of suitable hypothesis to avoid lack of relationship between the research questions and hypothesis.
- **Control:** A good research is capable of controlling all the variables. This necessitates randomization at all stages and ascertains sufficient control over the independent variables.
- **Universality:** A good research will almost have the same result by using identical methodology so that the result can be applied to similar situations.
- **Free from personal biases:** A good research is free from the researcher's personal biases and must be based on objectivity and not subjectivity.
- **Systematic:** A good research has several well-planned steps that are inter-connected and logical.
- **Reproductivity:** A researcher, while conducting the research, is able to obtain approximately the same results by using an identical methodology for conducting investigation.

1.2.1 Applications of Business Research

The discussion so far points out the role and significance of research in aiding business decisions. The question one might ask here is about the critical importance of research in different areas of management. Is it most relevant in marketing? Do financial and production decisions really need research assistance? Does the method or process of research change with the functional area?

The answer to all the above questions is NO. Business managers in each field—whether human resources or production, marketing or finance—are constantly being confronted by problem situations that require effective and actionable decision making. Most of these decisions require additional information or information evaluation, which can be best addressed by research. While the nature of the decision problem might be singularly unique to the manager, organization and situation, broadly for the sake of understanding, it is possible to categorize them under different heads.

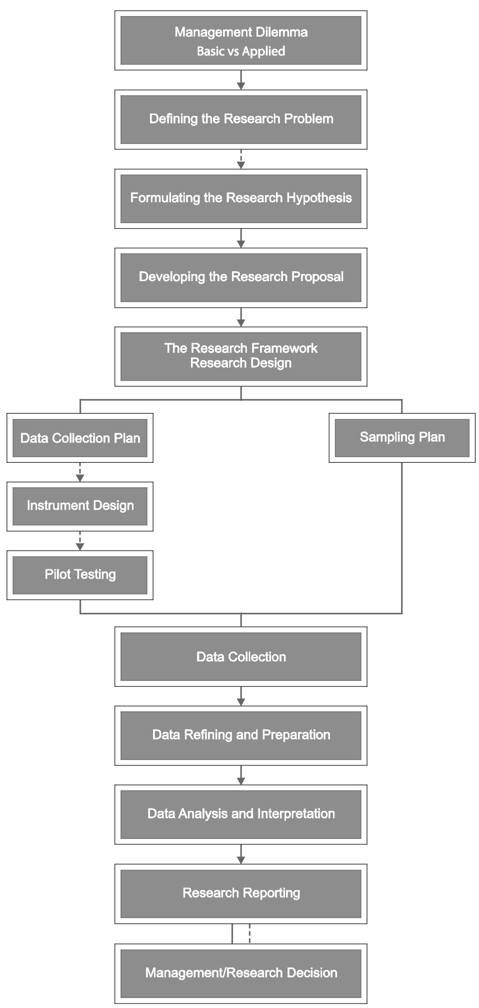


Fig 1.1 *The Process of Research*

Marketing function

This is one area of business where research is the lifeline and is carried out on a vast array of topics and is conducted both in-house by the organization itself and outsourced to external agencies. Broader industry- or product-category-specific studies are also carried out by market research agencies and sold as reports for assisting in business decisions. Studies like these could be:

- Market potential analysis; market segmentation analysis and demand estimation
- Market structure analysis which includes market size, players and market share of the key players
- Sales and retail audits of product categories by players and regions as well as national sales; consumer and business trend analysis—sometimes including short/long term forecasting

However, it is to be understood that the above mentioned areas need not always be outsourced; sometimes they might be handled by a dedicated research or new product development department in the organizations. Other than these, an organization also carries out researches related to all four Ps of marketing such as:

- Product research: This would include new product research; product testing and development; product differentiation and positioning; testing and evaluating new products and packaging research; brand research—including equity to tracks and imaging studies.
- Pricing research: It includes Price determination research; evaluating customer value; competitor pricing strategies; alternative pricing models and implications.
- Promotional Research: It includes everything from designing of the communication mix to design of advertisements, copy testing, measuring the impact of alternative media vehicles, impact of competitors' strategy.
- Place research: It includes locational analysis, design and planning of distribution channels and measuring the effectiveness of the distribution network.

These days, with the onset of increased competition and the need to convert customers into committed customers, customer relationship management (CRM), customer satisfaction, loyalty studies and lead user analysis are also areas in which significant research is being carried out.

Personnel and Human Resource Management

Human resources (HR) and organizational behaviour is an area which involves basic or fundamental research as a lot of academic, macro level research may be adapted and implemented by organizations into their policies and programmes. Applied HR research by contrast is more predictive and solution

NOTES

oriented. Though there are a number of academic and organizational areas in which research is conducted, yet some key contemporary areas which seem to attract more research are as follows:

- Performance management; leadership analysis development and evaluation; organizational climate and work environment studies; talent and aptitude analysis and management; organizational change implementation, management and effectiveness analysis
- Employee selection and staffing: This includes pre and on-the-job employee assessment and analysis; staffing studies
- Organizational planning and development: Culture assessment—either organization specific or the study of individual and merged culture analysis for mergers and acquisitions; manpower planning and development
- Incentive and benefit studies: These include job analysis and performance appraisal studies; recognition and reward studies, hierarchical compensation analysis; employee benefits and reward analysis, both within the organization and industry best practices
- Training and development: These include training need gap analysis; training development modules; monitoring and assessing impact and effectiveness of training
- Other areas include employee relationship analysis; labour studies; negotiation and wage settlement studies; absenteeism and accident analysis; turnover and attrition studies and work-life balance analysis

Critical success factor analysis and employer branding are some emerging areas in which HR research is being carried out. The first is a participative form of management technique, developed by Rockart (1981) in which the employees of an organization identify their critical success factors and help in customizing and incorporating them in developing the mission and vision of their organization. The idea is that a synchronized objective will benefit both the individual and the organization, and which will lead to a commitment and ownership on the part of the employees. Employer branding is another area which is being actively investigated as the customer perception (in this case it is the internal customer, i.e., the employee) about the employer or the employing organization has a strong and direct impact on his intentions to stay or leave. Thus, this is a subjective qualitative construct which can have hazardous effect on organizational effectiveness and efficiency.

Financial and Accounting Research

The area of financial and accounting research is so vast that it is difficult to provide a pen sketch of the research areas. In this section, we are providing just a brief overview of some research topics:

- Asset pricing, corporate finance and capital markets: The focus here is on stock market response to corporate actions (IPOs, takeovers and mergers), financial reporting (earnings and firm specific announcements) and the impact of factors on returns, e.g., liquidity and volume;
- Financial derivatives and interest rate and credit risk modelling: This includes analysing interest rate derivatives, development and validation of corporate credit rating models and associated derivatives; analysing corporate decision making and investment risk appraisal;
- Market based accounting research: Analysis of corporate financial reporting behaviour; accounting-based valuations; evaluation and usage of accounting information by investors and evaluation of management compensation schemes;
- Auditing and accountability: This includes both private and public sector accounting studies, analysis of audit regulations; analysis of different audit methodologies; governance and accountability of audit committees;
- Financial econometrics: This includes modelling and forecasting in volatility, risk estimation and analysis;
- Other related areas of investigation are in merchant banking and insurance sector and business policy and economics areas.

Considering the nature of the decision required in this area, the research is a mix of historical and empirical research. Behavioural finance is a new and contemporary area in which, probably, for the first time subjective and perceptual variables are being studied for their predictive value in determining consumer sentiments.

Production and Operation Management

This area of management is one in which quantifiable implementation of the research results takes on huge cost and process implications. Research in this area is highly focused and problem specific. The decision areas in which research studies are carried out are as follows:

- Operation planning: These include product/service design and development; resource allocation and capacity planning
- Demand forecasting and decision analysis
- Process planning: Production scheduling and material requirement management; work design planning and monitoring
- Project management and maintenance management studies
- Logistics and supply chain and inventory management analysis
- Quality estimation and assurance studies: These include total quality management (TQM) and quality certification analysis

This area of management also invites academic research which might be macro and general but helps in developing technologies such as JIT (just-in-time technology) and EOQ (economy order quantity—an inventory management model) which are then adapted by organizations for optimizing operations.

Cross-functional research

Business management being an integrated amalgamation of all these and other areas sometimes requires a unified thought and approach to research. These studies require an open orientation where experts from across the disciplines contribute to and gain from the study. For example, an area such as new product development requires the commitment of the marketing, production and consumer insights team to exploit new opportunities. Other areas requiring cross functional efforts are:

- Corporate governance and ethics—the role of social values and ethics and their integration into a company's working is an area that is of critical significance to any organization.
- Technical support systems, enterprise resource planning systems, knowledge management, and data mining and warehousing are integrated areas requiring research on managing coordinated efforts across divisions
- Ecological and environmental analysis; legal analysis of managerial actions; human rights and discrimination studies

Check Your Progress

1. What is the principal purpose of research?
2. What are some of the areas which involve basic or fundamental research?

1.3 TYPES OF RESEARCH

The types of research depend on the field in which the specific research study is performed. The different types of research are as follows:

- **Pure research**: This type of research is mainly concerned with identifying certain important principles in a specific field. It intends to find out information that has a broad base of application. Examples of fundamental research are John Robinson's imperfect competition theory in Economics and Maslow's hierarchy of needs theory in motivation and so on.
- **Applied research**: This type of research aims at finding a solution to an immediate problem, faced by a society or an industrial organization. It is supposed to discover a solution to some basic practical problems.

Applied research suggests corrective methods to minimize a social or business problem.

- **Historical research**: It is the process of systematic examination of past events to be able to present an account of what has happened in the past. Most people believe that it is a simply accumulation of dates and facts of past events. Actually, it is not so. It is a flowing, dynamic account of past events involving an interpretation of these events to understand the factors, personalities and ideas that influenced these events. One of the goals of historical research is to communicate an understanding of past events.

  Historical research is important because it:

  (i) Helps uncover the unknown or unrecorded facts/events

  (ii) Answers questions

  (iii) Facilitates identification of the relationship of the past has with the present

  (iv) Records and evaluates the accomplishments of individuals, agencies, or institutions.

  (v) Assists in understanding the culture in which we live

  It is not possible to identify any single approach that is used in conducting historical research. Some general steps that are typically followed, which include the following:

  (i) Identifying the research topic

  (ii) Formulating the research problem

  (iii) Collecting data and reviewing literature

  (iv) Evaluating materials.

  (v) Synthesizing data

  (vi) Preparing report

- **Futuristic research:** This type of research does not really predict the future as the name may seem to suggest. It is actually a branch of operations research aimed at conducting long-range planning based on forecasting using mathematical models, cross-disciplinary treatment of the subject, systematic use of expert judgements or opinions and a systems analytical approach.

- **Analytical research:** Analytical research is concerned with cause-effect relationships. For example, examining the fluctuations in India's international trade during a particular period of time would require descriptive research. However, to explain *why* and *how* Indian trade balance moves in a specific way over a period of time is an example of analytical research.

- **Synthetic research:** Synthetic research deals with basic mechanisms or relationships of the different mechanisms within the entire organism.

NOTES

This type of investigation depends neither on the methods used nor on the subject of investigations.

- **Descriptive research:** Descriptive research attempts to determine, describe, or identify *what* is unlike analytical research aimed at establishing *why* it is that way or how it came to be that way. Descriptive research uses descriptions, classifications, measurements, and comparisons to describe various phenomena.
- **Prescriptive research**: This type of research encompasses both the descriptive and explicative dimensions of research. The descriptive level aims to describe the research object whereas the explicative level interprets the observed phenomena. Prescriptive research tests the relevance of both explicative and prescriptive hypotheses. It supposes an interaction between the researcher and the field of study so as to implement recommendations or propositions and then measure their impact.
- **Survey research**: It is a collection of quantified data from a section of the population for describing or identifying between variables that may point to causal relationships or predictive patterns of influence. A census can be considered a survey that measures the nature of human resource available, their level of education, their professions, etc.
- **Experimental**: The experimental type of research enables you to calculate the findings, employ the statistical and mathematical devices and measure the results thus quantified.
- **Case study**: This method undertakes intensive research that requires a thorough study of a particular unit; for example, industrial or banking, for data collection.
- **Generic research**: It is research exists between applied research and basic research. It is considered to be a less academic way of researching used when research has to be conducted within a short frame of time. It results in a qualitative description showing how participants not only understand but also make sense of their experiences. The very lack of a specific method is the advantage of this research. Instead of being obsessed with one particular method, researchers use various procedures and strategies of data collection without being bound by too many technical and philosophical issues.
- **Formulative or exploratory**: It helps examine a problem with suitable hypothesis. This research, on social science, is mainly significant for clarifying concepts and innovations for further researches. The researchers are mainly concerned with the principles of developing hypothesis and testing with statistical tools.
- **Ex post facto**: This type of research is the same as experimental research, which is conducted to deal with the situations that occur in or around an organization. Examples of such a research are market failure

NOTES

of an organization's product being researched later and research into the causes for a landslide in the country.

- **Disciplinary research**: This research aimed at improving a discipline. It is concerned with the theories, relationships, and analytical procedures and techniques within the discipline, for example, economic research or social research.
- **Subject-matter research**: This is research on any subject of interest within a specific discipline.
- **Problem-Solving research**: It is research designed to solve a specific problem for a specific decision-maker. It is often multidisciplinary, for example, a multidisciplinary study of a new drug for cancer involving medical doctors, engineers, and an economist.

Besides these, there are several other types of research like evaluation research, survey research, assessment research and comparative research.

The researchers in quantitative research classify features of the research and then build the statistical models to explain what he observes. The researcher in quantitative research must know clearly in advance what he wants to research before he starts the research. Focus in this research is concise and narrow. Thus, quantitative research is conclusive. The data collected in this research is measurable and can be analysed easily by the researcher. Unlike qualitative research, quantitative research deals with what, where and when to research. This type of research is used in later phases of research cycle. Quantitative research is basically the study of numbers and statistics. The researcher can use different types of tools like questionnaires or equipment to gather this numerical information. The data collected in quantitative research is more effective than qualitative data and can help the researcher more. This type of research is not concerned with process. It only deals with what will be the outcome or product. Thus, the researcher in quantitative research tends to be objective; therefore, it is also called objective research.

It should be kept in mind that it is difficult to categorise a particular research under any major heads. This is because, no matter what the nature or method of research, the research problem is essentially treated in an interdisciplinary manner. Interdisciplinary treatment means the borrowing of an idea from related disciplines connected with the research topic for more authenticity. For example; management is not an individual discipline in its own right and requires an integral approach of various disciplines like finance and human resources, etc.

Check Your Progress

3. What is pure research concerned with?
4. List the names of any five types of research?
5. What is quantitative research?

NOTES

1.4 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. The principal purpose of research is to find solutions to problems systematically.
2. Human resources (HR) and organizational behaviour are areas which involve basic or fundamental research as a lot of academic, macro level research may be adapted and implemented by organizations into their policies and programmes.
3. Pure research is mainly concerned with identifying certain important principles in a specific field.
4. The types of research depend on the field in which the specific research study is performed. The five types of research are:
   (a) Pure research
   (b) Applied research
   (c) Historical research
   (d) Analytical research
   (e) Descriptive research
5. Quantitative research is basically the study of numbers and statistics. The researchers in quantitative research classify features of the research and then build the statistical models to explain what he observes. The researcher in quantitative research must know clearly in advance what he wants to research before he starts the research. Focus in this research is concise and narrow. Thus, quantitative research is conclusive.

1.5 SUMMARY

- The purpose of research is to find solutions through the application of systematic and scientific methods.
- The most important and difficult task of a researcher is to be as objective and neutral as possible.
- Good and effective research is identified by its nature, which signifies its focus on the research topic, a systematic way of implementation, control over the variables and so on.
- Business managers in each field—whether human resources or production, marketing or finance—are constantly being confronted by problem situations that require effective and actionable decision making. Most of these decisions require additional information or information evaluation, which can be best addressed by research.
- The types of research depend on the field in which the specific research study is performed.

NOTES

- The researchers in quantitative research classify features of the research and then build the statistical models to explain what he observes.

1.6 KEY WORDS

- **Fundamental Research:** It focuses on finding generalizations and formulating theories.
- **Applied Research:** It aims at finding a solution for an immediate problem facing a society or a business/industrial organization.
- **Total Quality Management:** It refers to a system of management based on the principle that every member of staff must be committed to maintaining high standards of work in every aspect of a company's operations.
- **Social Research:** This refers to research conducted by social scientists in order to analyse a vast breadth of social phenomena.
- **Quantifiable:** It means something that is able to be expressed or measured as a quantity.

1.7 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short Answer Questions

1. Distinguish between non-scientific and scientific method.
2. What are the characteristics of research?
3. Which type of research in concerned with cause-effect relationships?

Long Answer Questions

1. Describe the application of business research in various fields.
2. Explain the different types of research.
3. Discuss financial and accounting research in detail.

1.8 FURTHER READINGS

Creswell, John W. 2002. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. London: Sage Publications Inc.

Booth, Wayne, Gregory G. Colomb and Joseph M. Williams. 1995. *The Craft of Research*. Chicago: University of Chicago Press.

Bryman, Alan and Emma Bell. 2015. *Business Research Methods.* 4th Edition. United Kingdom: Oxford University Press.

Gupta, S.L. and Hitesh Gupta. 2012. *Business Research Methods.* New Delhi: Tata McGraw Hill Education Private Limited.

NOTES

UNIT 2 DIFFERENT TYPES OF RESEARCH AND ADVANCEMENTS

Structure

2.0 Introduction
2.1 Objectives
2.2 Recent Advancements in Research: Online Research
2.3 Distinction between Different Types of Researches
2.4 Answers to Check Your Progress Questions
2.5 Summary
2.6 Key Words
2.7 Self Assessment Questions and Exercises
2.8 Further Readings

2.0 INTRODUCTION

In the previous unit, you were introduced to various aspects of business research. Here we will discuss the advancements made in research in recent years. Business research, like all other domains, has been greatly influenced by technological advancements in recent years. Research that is carried out today bears no resemblance to business research of earlier times. One of the notable advances has been the advent of the Internet. We will discuss this aspect in detail. The unit will also discuss the differences between different types of research.

2.1 OBJECTIVES

After going through this unit, you will be able to:

- Describe online research and its data collection methods
- Discuss the differences between various types of research

2.2 RECENT ADVANCEMENTS IN RESEARCH: ONLINE RESEARCH

If the 1960s was the era of rationality and the search for universal paradigms and absolute truths which could stand the test of time and boundaries; the 1990s saw turmoil and uncertainty. As the aftermath of nuclear warfare and environmental calamities like pollution, global warming and genetic malformations led to post-modernism and a questioning mindset characterized by hostility and despair with the state of things. This resulted in hyper realities,

NOTES

where more and more people across the world sought a world that was surreal and thus free from the chaos and disappointments as well as threats of the real world. The need was ably supported by the extremely fast digital growth that was happening across the world. Today, almost two decades later, more than one million people across physical boundaries stand connected through online communities, networks, groups, forums and podcasts. The huge success of virtual social worlds such as Second life is a definite proof of the fact that more and more consumers are taking on an alternative identity (or avatar), which has no constraints or rules. This is only one part of it—the success of social communities (Facebook), virtual product sales (on forums such as Flipkart and Snapdeal) gaming (World of Warfare) and knowledge/opinion sharing (Twitter and Wikipedia) all point towards the relevance of seeking time and information from data sources that are available (secondary) and can be sought (primary) in a virtual environment.

The Relevance and Domain of Online Research

In the last decade, what we saw was the recognition of the Internet as a useful source of secondary information, such as databases and online resources. However, today it is being recognized as a separate method as it involves unique challenges and processes related to sampling, data collection and measurement metrics which are not prevalent in traditional research as we know it. Thus, it is critical to understand these issues from the perspective of using the medium effectively for conducting a research study.

A typical phenomenon of virtual space is that companies now have to face the true aspects of designing consumer centric strategies. Thus, for the new era of co-creation by consumers and business managers, the business researcher needs to be "listening" to what the brand communities are saying; "talking" with them for co creation; "energizing" and "supporting" to complete the engagement with the consumer. The medium is exciting and has huge potential, yet it is in an evolving stage as it faces constant challenges of changes in terms of business-customer interface as well as ethical constraints. Thus, both perspectives on recognizing the value of the process as well as serious concerns exist about it. Thus, before we go on to the specifics of the online research process, let us briefly examines the pros and cons of using the method.

Advantages and Disadvantages of Online Research

Just like the traditional research process we have gone through in the textbook this also has strengths and weaknesses associated with it. Some of these are listed below:

Advantages

The advantages are as follows:

- **Low cost:** The most supportive argument is the cost of conducting the online research. Researchers have found it to be almost 30% cheaper to

conduct a study online. The only significant cost the investigator may incur is in the use of the software to generate the study questionnaire. This has also been resolved to a certain extent as a number of free sites are available that can be used for designing and uploading the instrument. The second is the saving in the negligible to zero cost of reaching the sample respondents.

- **Quick response time:** This is both in terms of secondary data as well as collecting data that is primary in nature from the sample group.
- **Better respondent engagement:** With the innovation in design and tools available on the net the questionnaire and the information seeking can be made very engaging and interesting for the respondent.
- **Extensive reach:** The advantage of the virtual medium is that there are no distances in terms of approaching the sample group. Also, with advanced software available it is possible to enable an almost instant translation of the questions into the language of the respondent.
- **Anonymity and answering:** Since the researcher/investigator is in most instances not there, the respondent feels freer to answer and the relative anonymity gives them the assurance to answer, sensitive and open ended questions
- **Accuracy in data entry:** Since the response categories for the closed ended questions is done in the beginning there is no likelihood of human error in filling the answers in the spread sheet. The other records in terms of time off access and time taken to complete the questionnaire, etc., are precisely recorded and again this ensures zero error.
- **Authentic data sources:** With more and more companies and research agencies realizing the merit of the medium, reputed companies like Nielsen, Forrester and Euromonitor are establishing online divisions to cater to the needs of the business and academic researcher.

Disadvantages

The disadvantages are as follows:

- **Skewed sample:** The constraint of the method is that the data collected, especially primary, can only be conducted on people who are Internet-savvy. Thus, there is the issue of generalizability.
- **Representativeness and authenticity:** The anonymity of the respondent is also a problem as one does not know who is on the other side as the person might not reveal his/her true identity, age or gender. Thus, one may conduct and formulate conclusion based on a sample group that was not matching the population under study.
- **Significant cues:** A lot of physical cues that come from body language and voice modulations is lost in an online survey. Though this issue is being resolved to a certain extent by audio and video interviews and also

analysis of emoticons (smiley face and punctuation and word forms) in the text is being researched to try and overcome this weakness.

- **Malicious responses:** Once the questionnaire is posted for response one has no control over who responds. It might happen that a disgruntled employee or customer might be extremely negative and fill the questionnaire not once but multiple times and thus deform the output.
- **Design problems:** The online surveys are more engaging provided one knows how to make effective use of the software features. Thus, they are also difficult to design and the average online researcher might not be proficient in doing so.

The online research process is by and large the same in terms of steps involved. However, special mention needs to be made of three important issues-sampling; data collection and data metrics.

Sampling For Online Research Studies

One of the major challenges in online studies is designing an effective sampling plan and obtaining a representative sample. Since no concrete sampling frame exists of internet users, obtaining a probability sample is a difficult task. As a result of non-representativeness in sampling the sampling error becomes considerable and thus raising doubts with reference to the results of the study. In case the research study is being conducted on a finite group as amongst employees in a company or even students in universities, the population is finite and thus chances of error are minimized. Hence in the absence of sampling frame one should disperse the questionnaire on all relevant platforms, mailing lists, chat room, news group etc. However, there is still no way of knowing whether the sample who responded is representative of the population one wanted to study.

Added to the challenge is the fact that the same user may have multiple accounts. And updating and comprehending the accounts on which he is active/inactive is difficult to obtain. To a certain extent there are various companies across the Globe that have recognized the web-opportunity in the gap and provide the service of sampling users directly from various websites. Netzero is one such free Internet service provider. The company has a barter strategy and in exchange of complete profiling and tracking rights of user's site behaviour, it offers the use of free internet access. Despite the invasion of privacy, the company has more than 8 million users. Thus the firm has a data base of consumers and can to a certain extent assist in improving the representative nature of the sample and also based on the profile of consumers manage an experimental design of experimental and control group, better.

Another company utilizing this barter strategy is Knowledge Networks. This company uses RDD (random digit dialling) methods to recruit individuals for a household panel survey. This would need to be longitudinal in nature.

NOTES

The recruited and screened panellist is provided free Web TV receiver and internet access in exchange for agreeing to participate in the online panels/ surveys.

There are some typical ways of sampling on the net.

Open–Internet samples: This sample includes people who, for whatever reason volunteered to complete the online questionnaire survey. Some also opt for being part of online panels. This method suffers from the problem of self-selection. The second problem is that if the survey is too long they might get bore or lose interest and quit without completing the survey. Also, these are sometimes mailed and sometimes they might be rolled out as pop-up surveys. The challenge with executing pop-up surveys, being that most Internet users these days have a pop-up blocker. Sometimes, the researcher also does Internet–intercept survey, which involves interjecting into an Internet user's activity on a typical homepage of any site.

Screened–Internet samples: This screened sample could be from the open-sample group or they might be part of a particular data base or service provider like Net zero. They are first administered a screening questionnaire and then requested based on the study requirement to complete the survey. Sometimes using the screener it is also possible to classify them into separate segments. In this case it is possible to direct them towards separate questions based on their characteristics. For example in a study on compensation and rewards, there might be groups of Public sector workers as well as private, so they are directed towards different sections.

Recruited sample: These are members who are generally accessed like the traditional method that is once they are representative of the population under study they are contacted through mail, email, telephone or in person. And after they agree to answer the survey they are sent the questionnaire or the link to the questionnaire, with a password to complete it.

Data Collection Methods for Online Research

As is the case with traditional research process, online research also has the same basic two broad categories of data collection—primary and secondary.

I. Secondary Methods

Let us discuss the secondary data collection methods in detail.

Search engines

Today, one of the most powerful and most frequently used sources of secondary data is the Internet. A number of companies like Google, Wikipedia, MSN search, and Yahoo search have recognized the merit of having a full-fledged division dedicated to this. The search engines have their own programmed web crawlers, web spiders (these are like web robots and they

systematically “crawl” the Internet to search and index sites/information) of taking the “searcher” to various sites. Some popular methods are based on keywords and their density, after which they look at the link popularity—in terms of how many times it has been accessed—and today with monetization of sites, how much does one need to pay per click. There are again general search engines like Google and Yahoo and more specific in terms of, say, when you are looking for specifics in terms of let’s say statistical data related to Indian demographics, one goes to *www.censusindia.gov.in*. Because of the huge number of websites available with a single key term one may get 1000 or 10000 options and it is near impossible to tackle all of them, the other challenge is that a lot of sites , especially scholarly search sites like *www.hbsp.harvard.edu* (Harvard Business School publishing) require a password and cannot be accessed normally. Thus, the researchers may like to move to focused and reliable sites like Pathfinders. Pathfinders are basically sites that take the user to a limited portfolio of sites that are provided by credible sources. *www.pathfinderhealth.in* is a pathfinder that is focused on informational sites related to health and relevant to the Indian user/ practitioner. These sites have what are known as intelligent crawlers that index specific topic-related results.

Newsgroups

These are quite similar to other social media platforms. They are called newsgroups because they are a primary method of communication in a virtual world with like minded professionals (e.g. marketing academicians—*www.marketingpower.com*) or special interest groups (e.g. management aspirants— *www.pagalguy.com*). The “Internet reader” can view threads (conversation histories); pose questions to other group members or rebuke or disagree with points of views more or less as in a face-to-face argument. A typical newsgroup message looks very similar to an email. There is a sender, a subject title and the actual message. These threads are powerful sources of information as you as a researcher can browse through an entire thread and get a first hand qualitative insight into what the respondent population is thinking and doing.

Blogs

Blogs originated in the late 1990s when they were usually managed by an enthusiast who gave a chronological index of sites of interest and also provided a personal commentary on the links or sites. However, later people created their own private blogs, which were like public sharing of private, personal views and thoughts. The fact that they are in the public domain means they are accessible and sometimes ones expression of discontent or despair that reflects a personal misery creates a reaction and sometimes can lead to an uprising, as can be seen in a number of cases of rebellion in the years 2011–12. Marketing researchers find blogs as very interesting as they

are able to understand the lifestyle and beliefs about any consumer segment rather than merely the product or the brand, thus making targeting and positioning strategies more focused and meaningful. In fact there are search engines like *www.blogsearch.com* that can help a researcher conduct a blog search on any topic of interest.

II. Primary Methods

The premise of using the primary methods and the basic nuances of the techniques remain the same. In this section, we will highlight the aspects that are different and thus need to be taken care of while making use of any of these. There are also some primary methods–netnography—that are unique to this medium and will be dealt with in the end in some detail.

Before we proceed further, let us examine some categorization of online primary methods. One is between a web-based method in which the researcher could make use of a web designed questionnaire and collect the data from the respondent. The other is a communication method, which is more personalized and targeted towards collecting specific information from identified sample group. This involves using the email as a personalized platform for collecting information.

The other method is synchronized vs non-synchronized. In the first the researcher/interviewer asks questions and the respondent answers in real time while in the second case the questionnaire is sent to the respondent and he/she answers as per her convenience at a later time slot.

Online focus groups

The focus group is as rich in its conduct and usefulness as it is the real world. Here the focus croup could be both in the form of chat or discussion forums—where the group members are already familiar with each other or else they are selected through the Internet. The method could also be synchronized where all members and the moderator are discussing at a single moment in time. However, there could also be non-synchronized focus groups where the members might post their comments and then move out of the group to conduct other activities and someone else may respond much later and the user when he returns then responds to the comment. These are typically called bulletin boards.

As the method involves usually typing ones response it is recommended that since there could be simultaneous response from the group members rather than 8-10 as is the practice in a regular focus group one should limit oneself to 6-8 members. Secondly, the moderator must be fast in typing on the keyboard and be very familiar with handling diversions and interjections on the software platform. A typical online focus group last for about two hours. While some group members might be keying in their response others might react with emoticons like smileys, etc., to express their feelings for the

statement or comment. Since there could be multiple people who respond at the same time, it might be prudent to use two moderators so that multiple reactions can be handled at the same time. Just like the traditional method the online methods have their own challenges and advantages. The advantage primarily being in terms of cost, geographic reach and to a certain extent they do not involve facing a group. The disadvantages are that the richness of non-verbal cues are lost here.

Social network analysis

This method has its origin in Sociometry. Here, essentially one tries to study social or virtual social ties. This involves studying the structure—hierarchy and patterns of networks that emerge between social or virtual actors. There are essentially two aspects one is analyzing—nodes (the net users) and the ties (their relationship with each other). The ties could be a sharing of ideas, information a business transaction or an emotional transaction. One can do things in a social network—either observe the way the information is flowing—in terms of who is the centre of the network(opinion leader), who is the loner, are their two people who communicate more with each other (dyads). The second method is to ask questions and find out with whom the group members would interact for emotional problems or information/ knowledge seeking. Basically, the idea being to assess how decisions are taken in group settings and how group dynamics influence individual or group behaviour in a particular network.

Online surveys

The online survey may be conducted in both real time and non-synchronized. The survey could involve either of the following two methods:

- **E-mail-based surveys:** These are generally conducted after the sampling has been done and the email address of the respondent has been made available. Post which the study instrument may be attached with the mail or be embedded in the mail. in this case there would be a short introduction to the study and the respondent answers the questions and then carry out the simple action of reply , the filled questionnaire returns back to the researcher. The other method is that there is an attachment which needs to be downloaded and then filled in. This can be either sent back as an attachment or the physical copy can be mailed back to the researcher.
- **Web-based surveys:** These involve using software or a program to generate a questionnaire. This method has a huge advantage in terms of design capabilities. One can make the questionnaire engaging and interesting by making use of computer programs. Secondly, the option of filter and branching question that are tedious when done in the traditional manner are handled very efficiently here. In most instances

NOTES

the instrument requires the respondent to punch/key in the button indicating their response. There are multiple web survey packages available today that can help the researcher to efficiently design a web survey, e.g. Web surveyor; Perseus Survey Monkey; Zoomerang, etc. The software further segregate and categorize data by tabulating the responses. Thus the task of making a data entry and coding the data is saved as the human error in data entry is eliminated here. The basic challenge lies not in designing but in getting the respondent to the instrument and motivating them to complete the survey.

Netnography

Robert Z. Kozinets (2010) came up with an online method that has its roots in ethnographic analysis. Ethnography is basically an anthropological technique used quite actively today in the field of marketing and consumer research today. The method is distinguished from other primary methods as it uses multiple methods in conjunction with each other to arrive at a rich and holistic picture about a culture or a community. The methods popularly used are the observation method, semiotics, films, documentaries, conversational and discourse analysis, videography. The idea being to use every possible piece of communication/information that has been spouted/created by the user of that community to understand the apparent and latent aspects about the community.

Kozinet took the participant-observation method to understand discourse and conversations on the computer as the source of data. Thus the premise is that along with its other methods, ethnographic analysis must take into account the data obtained from a netnographic analysis.

Ethnography to netnographic analysis can be viewed as a continuum. At the one end is a face to face interaction-observation, dialogue, data collection, which is an ethnographic analysis. Let us say we want to study the world or challenges face by single mothers of autistic children. Now, let us say that these single mothers spend considerable time online, thus at the next stage we study these communities online and both the face to face and online methods provide us a rich understanding of their group in its entirety. The last stage is when we study only online communities—second life—and our observation are limited to only their online interaction. This method is called netnography. The method has its own set of peculiarities that need to be understood before we discuss the method of netnographic analysis. The first is alteration—the technology-based medium in which the interaction is happening is different from the traditional interaction as people move in and out of the platform, come back sometimes instantly and sometimes after days to respond to a message or communication. The second is the anonymous nature of the medium that lets the community member give vent to behavior, feelings and expression, that may never be possible in the actual

NOTES

world, however this can also be a challenge as it becomes extremely difficult to identify the community or even gender this person belongs to. The third aspect is accessibility, once part of an online community, one is privy to everything and anything that the person is doing in their virtual world and the last is that because of its very nature of storage, historical archiving of activity and communication is extremely easy.

A typical netnographic analysis involves adopting a structured approach.

- **Step 1- Identifying the research question and objectives:** Once done and you have identified what kind of information or knowledge that you seek about the community. You first need to visit sites frequented by the communities (secondary data) to understand their typical lingos, their concerns and patterns of communicating with each other.
- **Step 2- Identifying and approaching the communities:** Once you have understood them to a certain degree, the next thing is to identify the forums or groups on which they interact- these could be chat forums, bulletin board, and social networking sites. Next one needs to shortlist the communities that one wants to enter. It is suggested that one enters the groups that are interactive, active, heterogeneous and also the communication content is rich.
- **Step 3- Ethical immersion and participation in the communities:** At every stage in the study the researcher must follow an ethical path to the introduction and participation in a community. Thus the time when the researcher enters the community, explains the academic purpose of the desire to enter the community. The data collection here is also multi fold. It involves posting comments, posing questions, getting feedback, taking online initiative and taking leadership roles. The researcher has to decide about how the communication and online behaviour is to be recorded. It is advised however, that the researcher maintains observational field notes on these communication pieces.
- **Step 4- Data analysis and interpretation:** Like any other qualitative method, researcher needs to make sense of the huge amount of conversation pieces that he has gathered and tries and discerns the underlying or common patterns of ideas or behaviour. This can be done manually, where the researcher attempts to draw categories and tries to establish possible relationships or links between observed attitude or behaviour. Please understand this is not interpretation but analysis that is very similar to content analysis. There are also software programs such as CAQDAS (computer assisted qualitative data analysis) that do the same analysis in terms of looking at identifying and coding recurrent themes.

- **Step 5- Evaluating and interpreting netnographic data:** Kozinets has identified 10 criteria that a netnographic analysis must meet in order to consider the findings of the analysis as an accurate ground for establishing accurately any characterization about the community or culture under study. The premise essentially being that the developed ideas and constructs must be distinct from each other. They should be grounded in some theoretical framework, allow for flexibility of interpretation by other researchers and be able to inspire some kind of applied social action with reference to the community.

Today, netnography is a technique that is being applied to blogs, tweets, and social networking sites like face book, podcasts and videocasts. The technique becomes increasingly important as it is able to provide insights into how people think and react. The companies are able to connect with their customers/stakeholders better if they understand the person's inner world. The third use is that the research can provide valuable means of communicating with these communities in a manner and language that they understand and believe in.

Online data metrics

The research process involved in an online research study is very similar to that conducted otherwise. However there are certain variable measurements that are unique to online research. It is not possible to discuss each one of them at length; however, an attempt is made to give the reader a substantive idea about what to look for and how to measure it.

1. **Cookie:** Is the historical record on your computer of your visiting any website. Every cookie has an ID number, a domain name and an expiry date, thus becomes useful in tracking user behaviour.
2. **Webserver log files:** Most web hosts who create the website have an inbuilt mechanism of storing any request made there. Thus details about the user who accessed your site are available to you. One can program the web analytic software to record the visitor information in the manner you wish to.
3. **Page tagging:** Besides the web site one can tag individual pages on the website and record details of those who visited the page. As this is related to what we referred to as intelligent crawling where the user might be looking for specific information. There are free analytic services like Google analytics that can assist in this form of tracking.

Key performance indicator

Key performance indicators (KPIs) are essentially measures of outcome or the dependent variable and the researcher can decide what he/she wants to assess depending on the objective of the research study. Some Popular KPIs are:

NOTES

1. **Ad impression:** This is a measure of the number of times an ad banner is displayed on the Internet.
2. **Cost per thousand impressions (CPM):** This model based on impressions or essentially awareness was the model used till 1997. Post that the web marketer was more concerned about the viewer and the company paid for being seen by the user.
3. **CTR:** Click through rate is a percentage figure which is the ratio between the numbers of impressions an ad gets upon the number of times the ad was shown.
4. **Bounce rate:** Bounce rate indicates the number of people who visit a website's landing page and bounce back without browsing further.
5. **Open rate:** In case some information or link was sent by e-mail. Then the open rate is the number of people who opened the e-mail. This requires the HTML or image to open and in case this has been disabled by the recipient it cannot be used as a metrics
6. **CTOR (click to open rate):** In case a link was sent on an email then the CTOR measures the number of people who opened the link vs those who opened the e-mail.
7. **Conversion rate:** This is the proportion of people who visit your site vs those who carry out a specific action, say, purchase.
8. **Abandonment rate:** Those who start an action but quit before completing the required activity. Say making a payment at the payment gateway.
9. **Page views:** the number of pages on your site viewed by a site visitor.
10. **Absolute unique visitor:** The details of the visitor who visited your website at a unique time period- say an online promotion.
11. **New vs returning visitors:** Those who arrive at the page for the first time vs those who have visited the site earlier.
12. **Cost per click (CPC):** The ratio of the advertising spend vs the number of clicks the sponsored search or banner advertisement got. This was more important than CPM as a click would mean a higher probability that the user would convert into a purchase at the site.
13. **Transaction conversion rate (TCR):** This is the ratio of the fixed cost of advertising vs the numbers of conversions post the advertisement.
14. **Take rate = CTR X TCR:** Is the number of times a visitor clicks and then converts into a transaction.
15. **Return on ad dollars (ROA):** Is a measure of total revenue made (TCR)/ cost of internet marketing.
16. **Word of mouth (WOM):** this is an important metrics for evaluating social media effectiveness =

$$\frac{\text{Number of direct clicks + Number of clicks based on recommendation}}{\text{Number of direct clicks}}$$

These are examples of the output in terms of what is the objective of an online strategy. The business researcher might study either the pattern of these matrices across segments or communities or alternatively try to establish the antecedents of these as these insights are what are necessary for the business manager who wants to better manage his/her e-commerce activities.

2.3 DISTINCTION BETWEEN DIFFERENT TYPES OF RESEARCHES

We have already learned the meaning of different types of research in Unit 1. Let us recapitulate the distinctions between different major types of researches:

- **Pure vs Applied Research:** Pure research is also known as fundamental research. It is exploratory in nature and is conducted without any practical end-use in mind. Pure research driven by interest, curiosity or intuition, and its objective is to advance knowledge and to identify/explain relationships between variables. In general, applied research is not carried out for its own sake but in order to solve specific, practical questions or problems. It tends to be descriptive, rather than exploratory and is often based upon pure research.
- **Historical vs Futuristic Research:** Historical research entails understanding past events to predict future ones. On the other hand, futures research can be defined as a systematic study of possible future events and circumstances.
- **Synthetic vs Analytical Research:** A synthetic approach to research looks at the research question or topic from a holistic point of view. Here, the researcher tries to comprehend the parts of the problem by looking at the whole. An analytic approach to research would look at a topic from a constituent point of view. The researcher tries to comprehend the whole phenomenon by looking at the separate parts.
- **Descriptive vs Prescriptive Research:** Descriptive research is employed to describe characteristics of a population or phenomenon being studied. It does not answer questions about how/when/why the characteristics occurred. Prescriptive research, like Evaluative research, is applied rather than theoretical. It is different from evaluative research in that it goes a step further, beyond identifying success or performance or outcomes, and actually recommends solutions or new ideas.
- **Experimental vs Survey Research:** Experiment and survey methods is highly critical in data gathering. Both types of research is employed to test hypotheses and come up with conclusions. Research through

NOTES

experiments entails the manipulation of an independent variable and measuring its effect on a dependent variable. On the other hand, conducting surveys often entails the use of questionnaires and/or interviews. While experimental method is a type of experimental research, survey is a type of descriptive research.

- **Case vs Generic Researches:** Case studies are a type of descriptive research which encompasses detailed analysis of a single (or limited number) of people or events. Case studies are typically interesting because of the unusualness of the case. On the other hand, generic research or generic qualitative research is presumed to go beyond the observable constructs and variables that are not visible or measurable; rather they have to be deduced by different techniques.

Check Your Progress

1. What is the disadvantage of the skewed sample method?
2. List one challenge of online studies.
3. What are KPIs?
4. What is pure research also known as?

2.4 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. The disadvantage of the skewed sample method is that the data collected, especially primary, can only be conducted on people who are Internet-savvy.
2. One of the major challenges in online studies is designing an effective sampling plan and obtaining a representative sample.
3. Key performance indicators (KPIs) are essentially measures of outcome or the dependent variable and the researcher can decide what he/she wants to assess depending on the objective of the research study.
4. Pure research is also known as fundamental research.

2.5 SUMMARY

- In the last decade, what we saw was the recognition of the Internet as a useful source of secondary information, such as databases and online resources.
- A typical phenomenon of virtual space is that companies now have to face the true aspects of designing consumer centric strategies.

- One of the major challenges in online studies is designing an effective sampling plan and obtaining a representative sample.
- Since no concrete sampling frame exists of internet users, obtaining a probability sample is a difficult task.
- As is the case with traditional research process, online research also has the same basic two broad categories of data collection—primary and secondary.
- The premise of using the primary methods and the basic nuances of the techniques remain the same.
- The focus group is as rich in its conduct and usefulness as it is the real world. Here the focus croup could be both in the form of chat or discussion forums—where the group members are already familiar with each other or else they are selected through the Internet.
- The research process involved in an online research study is very similar to that conducted otherwise. However there are certain variable measurements that are unique to online research.
- Transaction conversion rate (TCR): This is the ratio of the fixed cost of advertising vs the numbers of conversions post the advertisement.
- Historical research entails understanding past events to predict future ones. On the other hand, futures research can be defined as a systematic study of possible future events and circumstances.
- Case studies are a type of descriptive research which encompasses detailed analysis of a single (or limited number) of people or events.

2.6 KEY WORDS

- **Questionnaire:** It refers to a set of printed or written questions with a choice of answers, devised for the purposes of a survey or statistical study.
- **Case Studies:** It refers to process or records of research into the development of a particular person, group, or situation over a period of time.
- **Ethnography:** It refers to the scientific description of peoples and cultures with their customs, habits, and mutual differences.
- **Focus Group:** It refers to a group of people assembled to participate in a discussion about a product before it is launched, or to provide feedback on a political campaign, television series, etc.

2.7 SELF ASSESSMENT QUESTIONS AND EXERCISES

NOTES

Short-Answer Questions

1. What are blogs?
2. Write a short-note on online surveys.
3. What is prescriptive research?

Long-Answer Questions

1. Differentiate between various types of research.
2. What is online research? Discuss its advantages and disadvantages.
3. Examine the data collection methods for online research.

2.8 FURTHER READINGS

Creswell, John W. 2002. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. London: Sage Publications Inc.

Booth, Wayne, Gregory G. Colomb and Joseph M. Williams. 1995. *The Craft of Research*. Chicago: University of Chicago Press.

Bryman, Alan and Emma Bell. 2015. *Business Research Methods.* 4th Edition. United Kingdom: Oxford University Press.

Gupta, S.L. and Hitesh Gupta. 2012. *Business Research Methods.* New Delhi: Tata McGraw Hill Education Private Limited.

UNIT 3 SIGNIFICANCE OF RESEARCH

NOTES

Structure

3.0 Introduction
3.1 Objectives
3.2 Constructing Hypothesis
3.2.1 Identifying Variables
3.2.2 Characteristics and Functions
3.2.3 Types of Hypotheses
3.3 Significance of Research in Social Sciences
3.4 Scientific Method: Induction and Deduction
3.5 Process of Research
3.6 Answers to Check Your Progress Questions
3.7 Summary
3.8 Key Words
3.9 Self Assessment Questions and Exercises
3.10 Further Readings

3.0 INTRODUCTION

In the previous unit, you were introduced to recent advancements in research. In this unit, the discussion on hypothesis will be done. You will learn about how to construct hypothesis. A hypothesis is constructed after the preliminary research is conducted. The hypothesis is worded in such a way that it can be tested in the experiment(s) and it must encompass both independent and dependent variables. The unit will also discuss the significance of research in the social sciences and concepts of induction and deduction. The process of research is also explained here.

3.1 OBJECTIVES

After going through this unit, you will be able to:

- Discuss the different types of variables
- Understand the significance of research in social science
- Examine inductive and deductive reasoning
- Describe the process of research

3.2 CONSTRUCTING HYPOTHESIS

Let us begin the discussion on constructing a hypothesis by examining how to identify variables.

3.2.1 Identifying Variables

NOTES

To carry out an investigation, it becomes imperative to convert the concepts and constructs to be studied into empirically testable and observable variables. A variable is generally a symbol to which we assign numerals or values. A variable may be dichotomous in nature, that is, it can possess only two values such as male–female or customer–non-customer. Values that can only fit into prescribed number of categories are discrete variables, for example, occupations can be: Teacher (1), Civil Servant (2), Private Sector Professional (3) and Self-employed (4). There are still others that possess an indefinite set, e.g., age, income and production data.

Variables can be further classified into five categories, depending on the role they play in the problem under consideration.

- **Dependent variable:** The most important variable to be studied and analysed in research study is the dependent variable (DV). The entire research process is involved in either describing this variable or investigating the probable causes of the observed effect. Thus, this in essence has to be reduced to a measurable and quantifiable variable. For example, in the organic food study, the consumer's purchase intentions and the retailers stocking intentions as well as sales of organic food products in the domestic market, could all serve as the dependent variable.

  A financial researcher might be interested in investigating the Indian consumers' investment behaviour, post the recent financial slow down. In another study, the HR head at Cognizant Technologies would like to study the organizational commitment and turnover intentions of short and long tenure employees in the company.

  Hence, as can be seen from the above examples, it might be possible that in the same study there might be more than one dependent variable.

- **Independent variable:** Any variable that can be stated as influencing or impacting the dependent variable is referred to as an independent variable (IV). More often than not, the task of the research study is to establish the causality of the relationship between the independent and the dependent variable(s). The proposed relations are then tested through various research designs.

In the organic food study, the consumers' attitude towards healthy lifestyle could impact their organic purchase intention. Thus, attitude becomes the independent and intention the dependent variable. Another researcher might want to assess the impact of job autonomy and role stress on the organizational commitment of the employees; here job autonomy and role stress are independent variables.

- **Moderating variables:** Moderating variables are the ones that have a strong contingent effect on the relationship between the independent and dependent variables. These variables have to be considered in the expected pattern of relationship as they modify the direction as well as the magnitude of the independent–dependent association. In the organic food study, the strength of the relation between attitude and intention might be modified by the education and the income level of the buyer. Here, education and income are the moderating variables (MVs).

In a consulting firm, the management is looking at the option of introducing flexi-time work schedule. Thus, a study might need to be taken to see whether there will be an increase in productivity of each individual worker (DV) subsequent to the introduction of a flexi-time (IV) work schedule.

In real time situations and actual work settings, this proposition might need to be revised to take into account other impacting variables. This second independent variable might need to be introduced because it has a significant contribution on the stated relationship. Thus, we might like to modify the above statement as follows:

There will be an increase in productivity of each individual worker (DV) subsequent to the introduction of a flexi-time (IV) work schedule, especially amongst women employees (MV).

There might be instances when confusion might arise between a moderating variable and an independent variable.

Consider the following situation:

- ***Proposition 1:*** Turnover intention (DV) is an inverse function of organizational commitment (IV), especially for workers who have a higher job satisfaction level (MV).

While another study might have the following proposition to test.

- ***Proposition 2:*** Turnover intention (DV) is an inverse function of job satisfaction (IV), especially for workers who have a higher organizational commitment (MV).

Thus, the two propositions are studying the relation between the same three variables. However the decision to classify one as independent and the other as moderating depends on the research interest of the decision maker.

To understand the impact and role of the moderator variable let us represent the relationships graphically (Figure 3.1). Here *a* represents the effect of the independent variable (job satisfaction); *b* represents the effect of the second variable moderator variable (organizational commitment) and *c* represents the moderating effect, which is the combined effect of

the moderating variable and the independent variable on the dependent variable. Thus, the effect of *c* has to be large enough and significant enough (statistically) to prove the moderation hypotheses.

NOTES

- **Intervening variables:** An intervening variable (IVV) has a temporal connotation to it. It generally follows the occurrence of the independent variable and precedes the dependent variable. Tuckman (1972) defines it as 'that factor which theoretically affects the observed phenomena but cannot be seen, measured, or manipulated; its effects must be inferred from the effects of the independent variable and moderator variables on the observed phenomenon.'

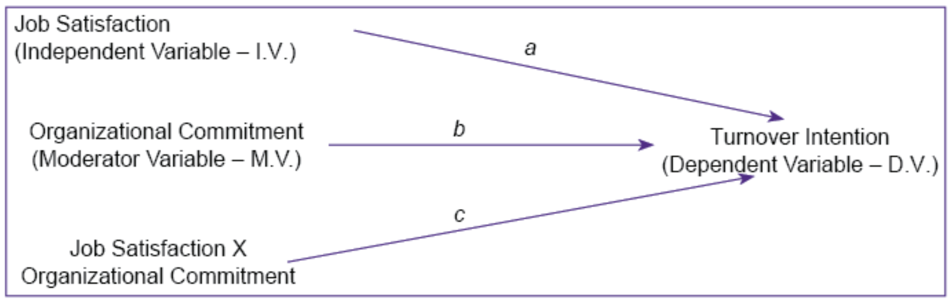


Fig 3.1 *Graphical representation of moderating variable: Proposition 2*

For example, in the previous case, There is an increase in job satisfaction (IVV) of each individual worker, subsequent to the introduction of a flexi-time (IV) work schedule, which eventually affects the Individual's productivity (DV), especially amongst women employees (MV). Another example would be, the introduction of an electronic advertisement for the new diet drink (IV) will result in increased brand awareness (IVV), which in turn will impact the first quarter sales (DV).This would be significantly higher amongst the younger female population (MV).

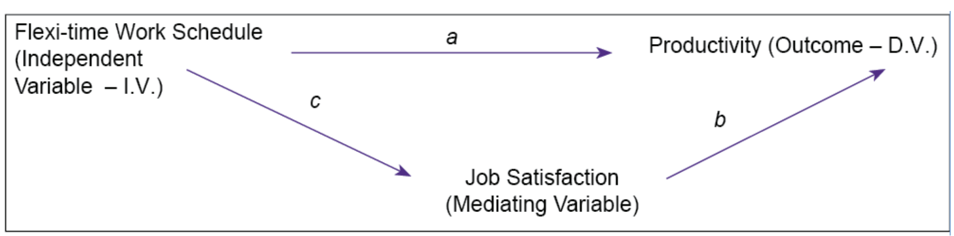


Fig 3.2 *Graphical Representation of Mediating Variable*

In current research terminology, the intervening variable is also called a mediating variable, as it mediates the strength and direction of the relationship between the independent and dependent variable (Figure 3.2). For example in

the above case, the direct effect of the predictor or the independent variable is measured by *a*; and the mediating impact of the mediating variable is represented by *b*. However, the point to be noted is that the independent variable acts on the mediating variable as represented by *c*. Thus, to prove a mediating relationship, one would expect that the effect of *b* would be more than the effect of *a* and that this could be proven to be significantly significant. The best case of mediation would be if *a* was zero or the predictor had no direct effect on the outcome variable. The impact of the mediating variable is assessed by the method of structural equation modelling.

- **Extraneous variables:** Besides the moderating and intervening variables, there might still exist a number of extraneous variables (EVs) which could affect the defined relationship but might have been excluded from the study. These would most often account for the chance variations observed in the research investigation. For example, a tyrannical boss; family pressures or nature of the industry could impact the flexi-time impact, but since these would be applicable to individual cases, they might not heavily impact the direction of the findings. However, in case the effect is substantial, the researcher might try to block their effect by using an experimental and a control group (This concept will be discussed later in the section on experimental designs).

At this stage, we can clearly distinguish between the different kinds of variables discussed above. An independent variable is the prime antecedent condition which is qualified as explaining the variance in the dependent variable; the intervening variable follows the occurrence of the independent variable and may in turn impact the dependent variable; the moderating variable is a contributing variable which might impact the defined relationship; the extraneous variables are outside the domain of the study and responsible for chance variations, but in some instances, their effect might need to be controlled.

3.2.2 Characteristics and Functions

Any assumption that the researcher makes on the probable direction of the results that might be obtained on completion of the research process is termed as a ***hypothesis***. Unlike the research problem that generally takes on a question form, the hypotheses is always in a declarative form. The statements thus formulated can lend themselves to empirical enquiry. Kerlinger (1986) defines a hypothesis as '…a conjectual statement of the relationship between two or more variables.' According to Grinnell (1993), 'A hypotheses is written in such a way that it can be proven or disproven by valid and reliable data—it is in order to obtain these data that we perform our study'.

NOTES

While designing any hypotheses, there are a few criteria that the researcher must fulfil. These are:

- A hypothesis must be formulated in simple, clear, and declarative form. A broad hypothesis might not be empirically testable. Thus, it might be advisable to make the hypothesis unidimensional, and to be testing only one relationship between only two variables at a time.
  - o Consumer liking for the electronic advertisement for the new diet drink will have positive impact on brand awareness of the drink.
  - o High organizational commitment will lead to lower turnover intention.
- A hypothesis must be measurable and quantifiable so that the statistical authenticity of the relationship can be established.
- A hypothesis is a conjectual statement based on the existing literature and theories about the topic and not based on the gut feel or subjective judgement of the researcher.
- The validation of the hypothesis would necessarily involve testing the statistical significance of the hypothesized relation. For example, the above two hypotheses would need to use correlation and regression analysis respectively to test the stated relationship.

3.2.3 Types of Hypotheses

The formulated hypothesis could be of two types:

1. **Descriptive hypothesis:** This is simply a statement about the magnitude, trend or behaviour of a population under study. Based on past records, the researcher makes some presumptions about the variable under study. For example:
   - Students from the pure science background score 90–95 per cent on a course on Quantitative Methods.
   - The current advertisement for the diet drink will have a 20–25 per cent recall rate.
   - The attrition rate in the BPO sector is almost 33 per cent.
   - The literacy rate in the city of Indore is 100 per cent.

NOTES

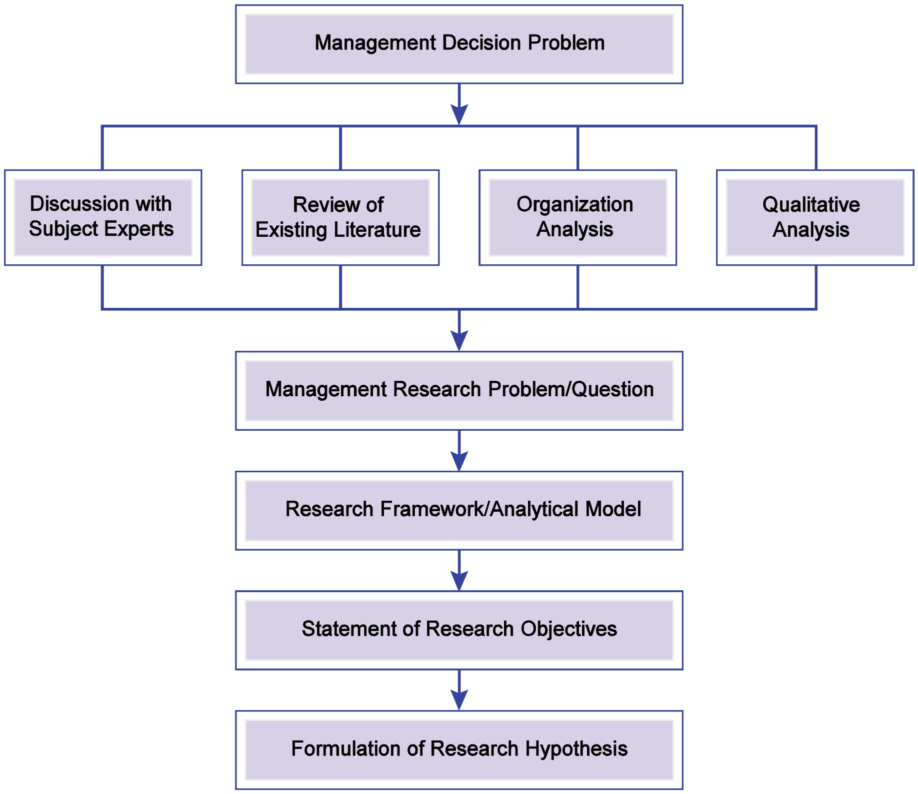


Fig 3.3 *Problem Identification Process*

2. **Relational hypothesis:** These are the typical kind of hypotheses which state the expected relationship between two variables. While stating the relation if the researcher makes use of words such as increase, decrease, less than or more than, the hypothesis is stated to be directional or one-tailed hypothesis.

   For example,

   - Higher the likeability of the advertisement, the higher is the recall rate.
   - Higher the work exhaustion experienced by the BPO professional, higher is the turnover intention of the person.

   However, sometimes the researcher might not have reasonable supportive data to hypothesize the expected direction of the relationship. In this case, he or she would leave the hypothesis as non-directional or two-tailed.

   For example,

   - There is a relation between quality of working life and job satisfaction experienced by employees.
   - Ban on smoking has an impact on the cigarette sales.
   - Anxiety is related to performance.

The hypotheses discussed in this section are in prose form and in a verbal declarative sentence form.

NOTES

Check Your Progress

1. What is a variable?
2. What is a descriptive hypothesis?

3.3 SIGNIFICANCE OF RESEARCH IN SOCIAL SCIENCES

Research plays an important role in many application areas. Some of them are as follows:

- **Finance, budgeting and investments**: This includes the following activities:
  - o Cash flow analysis, long-range capital requirements analysis, investment policies and dividend policies creation
  - o Creation of credit policies, credit risks and account procedures such as deposits and withdrawals
- **Purchasing, procurement and exploration**: This includes the following activities:
  - o Determining the quantity and time of purchase of raw materials, machinery and the like.
  - o Defining the rules for buying and supplying products under varying prices
  - o Determining the quantities and timings of purchases of finished products
  - o Formulating strategies for exploration and exploitation of new material sources
- **Production management**: This includes physical distribution of products, facility planning and manufacturing planning.
  - o **Physical distribution**: It is further divided into the following elements:
    - – Location and size of the warehouses, distribution centres, retail outlets and so on.
    - – Distribution policy
  - o **Facility planning**: It is further divided into the following elements:
    - – Production scheduling and sequencing of available resources

  - Project scheduling and allocation of resources
  - Determining the optimum production mix
- o **Manufacturing planning**: It is further divided into maintenance policies and preventive maintenance

- **Research and development**: It includes the following activities:
  - o Determining the areas of concentration of research and development
  - o Reliability and evaluation of alternative designs of research and development
  - o Control of developed projects
  - o Coordination of multiple research projects
  - o Determining the time and cost requirements

3.4 SCIENTIFIC METHOD: INDUCTION AND DEDUCTION

Good business research is based on sound reasoning such as finding premises that are correct, testing the connections between their assumptions and facts, making claims that are based on adequate evidence. In the reasoning process, induction and deduction, observation and hypothesis testing can be combined in a systematic way for producing scientific results. Scientific methods are practised in business research to guide our approach to problem solving. Some of the essential tenets of the scientific methods are:

- Observation of phenomena
- Clearly-defined procedures, methods and variables
- Empirically testable hypotheses
- Ability to rule out rival hypotheses
- Statistical justification of conclusions
- The self-correcting process

The researcher using this approach of 'empiricism' attempts to describe, explain and make applications by relying on the information gained through observation. Clearly, reasoning is pivotal to much of the researcher's success, which can be conveyed through one of the two types of discourse: exposition or argument. *Exposition* consists of statements that describe without attempting to explain. *Argument* allows us to defend, challenge, explain, interpret and explore meaning. The two types of argument that are of great importance to research are: deductive thought and inductive thought.

The second concern in formulating business research problems is the fact that more often than not, managers become aware of problems, seek information and arrive at decisions under conditions of bonded rationality. A

NOTES

concept formalized by March and Simon (1958) which implies that managers do not always work and take decisions in a perfectly rational sequence. The model says that information search or problem recognition phase like any other behaviour has to be motivated. Unless the manager is driven by present levels of dissatisfaction or by high expected value of outcomes, the process does not start. The next implication of the model is that in most instances, a manager does not have access to complete and perfect information. And further, the manager might try to seek reasonably convenient and quick information that meets minimal rather than optimal standards.

Deductive thought

Deductive thought, also called deductive logic, is the process of reasoning from one or more general statements regarding what is known to reach a logically certain conclusion. It involves using given true premises to reach a conclusion that is also true. Under deductive logic, a specific conclusion is arrived at from a general principle. If the rules and logic of deduction are followed, this procedure ensures an accurate conclusion. Deductive arguments are evaluated in terms of their validity and soundness. Deductive logic or reasoning is usually considered to be a skill that develops without any formal teaching or training.

Using deductive reasoning, researchers come up with a conclusion based on facts that have already been shown to be true. Hence, their conclusion is always true. The facts they use to prove their conclusion deductively may come from accepted definitions, postulates or axioms, or previously proved theorems.

This kind of logic is a culmination, a conclusion or an inference drawn as a consequence of certain reasoned facts. The reasons cited have to be real and not a figment of the researcher's judgement and second, the deductions or conclusions must essentially be an outcome of the same reasons.

Unless all probable reasons have been isolated and identified, the nature of the inference is incomplete.

Inductive thought

On the other end of the continuum is inductive thought. Here there is no strong and absolute cause and effect between the reasons stated and the inference drawn. Inductive reasoning calls for generating a conclusion that is beyond the facts or information stated.

Inductive thought, also known as inductive logic or inductive reasoning, constructs or evaluates propositions that are abstractions of observations of individual instances. In inductive reasoning, a general conclusion is arrived at by specific examples. Inductive logic is the process of coming up with a conclusion based on a series of events that repeat. An example would be to

push a light switch up turns on the light and pushing it down turns the light off. If this is done again and again, say 100 times, it may be concluded that the light goes on when the switch is up and it is off when the switch is down. However, the conclusion may not always be true because other circumstances may cause the light to not go on when the switch is up, such as the light may burn out, the electricity may go off, etc.

Thus, the fact of the matter is that inductive thought draws assumptions and hypothesis which could explain the phenomena observed and yet there could be other propositions which might explain the event as well as the one generated by the manager/researcher. Each one of them has a potential truth in it. However, we have more confidence in some over the others, so we select them and seek further information in order to get confirmation.

In practice, scientific thought actually makes use of both inductive and deductive reasoning in a chronological order. We might question the phenomena by an inductive hypothesis and then collect more facts and reasons to deduct that the hypothesized conclusion is correct.

Features of a Good Research Study

In the above section we learnt that one method of arriving at solutions to our professional dilemmas is through research. This method of enquiry, we will subsequently learn can vary from the loosely structured method based on observations and impressions to the strictly scientific and quantifiable methods. However, whatever be the method of enquiry, it must adhere to certain historically established criteria to be termed as business research. For a research to be of value and to authenticate or contribute to the body of knowledge, we feel that it must possess the following characteristics:

(a) It must have a clearly stated purpose that is implicit as when the purpose is to develop a new system of inventory management or explicit to establish quality standards for the service delivery model in our mobile eye care unit. This not only refers to the objective of the study, but also precise definition of the scope and domain of the study. The variables and constructs that are being investigated—service delivery model, quality standards, inventory management—need to be defined in clear and precise terms.

(b) It must follow a *systematic and detailed plan* for investigating the research problem. The source from which information is to be collected about quality standards inventory models has to be listed. In case the data is to be collected from a sample of suppliers, retailers and pathologists for investigating the gaps in the current inventory model, the detailing of how representativeness of the sample to the total population is to be ensured along with estimated error has to be specified. The systematic conduction also requires that all the steps in the research process are interlinked and sequential in nature.

NOTES

(c) The selection of techniques of collecting information, sampling plans and data analysis techniques must be supported by a logical *justification*. In case you are selecting a secondary data source only or going for an online survey, or rather than going to pathologists going to the ENT specialists for your hearing aid study, the reason for doing so, along with a clear demonstrable link to the research purpose is an absolute must.

(d) The results of the study must be presented in an *unbiased***,** *objective* and *neutral manner*. The significant findings can, at best, be supported by past researches, research approach and limitation, or by expert opinion. The researchers' own judgements and biases should not be revealed at any cost, even when the scope of the study demands providing recommendations.

(e) The research that you undertake can never be fruitful if it corners or if it exploits the rights of the respondents. Thus, the research at every stage and at any cost must maintain the *highest ethical standards*. For example, for the hearing aids study, if through the survey we identify the pivotal influence of the pathologist in the hearing aid purchase decision; the pathologists could be given a commission for bad mouthing the competitor's products to steer the customers towards our product even when there is a delay in delivery, thus improving our profits without any major changes implemented in the faulty inventory reporting. But this would be unethical.

(f) And lastly, the reason for a structured, ethical, justifiable and objective approach is the fact that the research carried out by us must be *replicable*. This means that the process followed by us must be 'reliable', i.e., in case the study is carried out under similar constraints and conditions it should be able to reveal similar results.

Check Your Progress

3. What does production management include?
4. What does exposition consist of?
5. How should the results of the study be presented?

3.5 PROCESS OF RESEARCH

The process of research is implemented as a series of actions or steps that are essentially performed in a specific order. These actions or activities usually overlap each other rather than pursuing a specific sequence. A brief description of the steps is given as follows:

NOTES

- **Selecting the topic**: The first step of a researcher is to select a topic of research. While doing so, he should restrict himself to the most potential topic that is open for extensive research out of several alternatives. The factors to be considered for topic selection are:
  - o Relevance
  - o Scope for research, i.e. the required data should be available and accessible
  - o Contribution to knowledge in the specific field
  - o Required cooperation from the research guide
- **Define the research problem**: There are two types of research problems:
  - o Problems related to the state of nature
  - o Problems related to the relationship of variables

  In defining the research problem, the researcher should study the existing literature like books and journals, available in the field with an interdisciplinary perspective to base his research topic on some reliable background. He should also concentrate on the relevance of the present research with the past works.
- **Mention the objective of research**: After selecting the topic and defining the research problem, the researcher should mention the objective of research. This means that he should explain what he aims to achieve through the research. His objective should also explain the extent to which the research work is related to the specific field.
- **Survey existing literature**: To understand the basis of research, it is important for the researcher to review the existing literature. This involves:
  - o Surveying the existing books available in the field
  - o Reviewing other published literature like articles, journals, reports, conference proceedings etc.

  The researcher should then prepare his own index for a period, in chronological order, in addition to his consultation of various indices.
- **Development of working hypothesis:** A hypothesis is an uncertain statement that involves the proposed answer to the problem. The hypothesis statement provides high priority to accountability and responsibility of research procedure. The solution proposed by working hypothesis cannot be considered as the only solution to the research problem. It only acts as the chain or interface between the theory and the research problem. It can also be considered as the point of departure. Hypotheses are thus the tentative statements that can either by rejected or accepted after the research process. Hypothesis also provides a

NOTES

structure and guides the researcher in the direction he should move to reach the solution of the problem. The researcher must keep the following things in mind while formulating a working hypothesis:

- o Hypothesis can only be developed after the researcher is certain about the nature, extent and intensity of the problem.
- o Hypothesis should be figured out throughout the research process which provides appropriate structure to the problem.
- o The researcher should keep it in mind that hypothesis is only the tentative statements/solutions of the problem and this hypothesis should not be generalised much.
- o A research problem does not need to have only one hypothesis. It only depends on the research proposal that how many hypotheses are required to solve the problem.

- **Preparing the research design:** Once the researcher has gained enough knowledge about the problem statement, he needs to prepare the plan that will act as the outline of the investigation in research process. The research design consists of a series of steps that has to be carried out during research.

  There are two types of research design:
  - o Exploratory research
  - o Conclusive research
  - o Descriptive research
  - o Causal research
- **Exploratory research:** The researcher conducts exploratory research when the problem has not been defined or he has not gained much knowledge about the research problem. Exploratory research allows the researcher to become familiar with the problem or the concept to be studied. The researcher can determine the best research design, data collection method and selection of subjects with this research. Sometimes, this research can also conclude that the problem does not exist. Exploratory research can be quite informal and can rely on secondary research and qualitative research.
- **Conclusive research:** As specified by its name is used to provide information that can help the researcher to reach to conclusion or decision-making. This search is likely to be quantitative in nature. It depends on both secondary data, which is also called existing data, and primary research, or data that is collected for the current study only.
  - o *Descriptive research:* Descriptive research, also called statistical research, provides data about the population or universe that has to be studied during research. Descriptive research provides

NOTES

information about 'who, what, when, where and how' of a situation but it does not provide information about who caused the problem. The researcher can use the descriptive research when the objective is to provide systematic, accurate and factual description. There are two types of descriptive research design:

  - Observations
  - Surveys

- *Causal research:* It is used to find out the variable causing certain behaviour. This research is applicable when the researcher has the knowledge of variables that are causing the problem and that are affected by the problem. This type of research tends to be very complex and the researcher may sometimes be unable to determine the attitude of an individual by this research. There are two types of causal research design:
  - Experimentation
  - Simulation

- **Determine the sample design**: Often only a few items are selected for universal study purposes, for example, blood testing on a sample basis to perform census inquiry. The items selected are technically known as a sample. The researcher must decide the way of selecting a sample or decide about sample design. A sample design is a definite plan determined for data collection to obtain a sample from a given population. The various types of sample designs are as follows:
  - Deliberate sampling
  - Simple random sampling
  - Systematic sampling
  - Stratified sampling
  - Quota sampling
  - Cluster sampling
  - Multi-stage sampling
  - Sequential sampling

  The researcher should decide the sample design after considering the nature of inquiry and other related factors. Sometimes several above-mentioned methods of sampling are used in the same study, which is called mixed sampling.

- **Data collection**: There are a variety of ways to collect data. Primary data can be collected through experiments or through surveys. If the researcher performs an experiment, he observes some quantitative measurements. This helps him examine the validity of his hypothesis.

NOTES

In the case of surveys, however, the researcher can adopt one or more of the following ways to collect data:

- o By observation
- o Through personal interviews
- o Through telephone interviews
- o By mailing of questionnaires
- o Through schedules

- **Execution of project**: This is the most important step in the research process. The researcher should ensure that the project is performed in a logical way and in time. If a survey is to be carried out, steps should be taken to ensure that it is under statistical control, so that the collected data is in accordance with the pre-determined standard of accuracy.
- **Analysis of data**: After data collection, the researcher turns to the task of analysing it. The bulk data should be compressed into a few manageable groups and tables for further analysis. The researcher can then analyse the collected data by using various statistical measures.
- **Hypothesis testing**: After analysing the data, the researcher should test the hypothesis, if any. He should check if the facts support the hypothesis or are contrary. Statisticians have developed tests like Chi square test, t-test and F-test for hypothesis testing. This testing further results in either acceptance or rejection of hypothesis.
- **Generalisations and interpretations**: The real value of research lies in its ability to arrive at certain generalisations. If the researcher cannot find a hypothesis to start with, he might seek to explain his findings on the basis of some theory. This is called interpretation. This may give rise to new questions and lead to further research.
- **Preparation of report or thesis**: This is the concluding step of research, where the researcher has to prepare a report of what has been done by him. Generally, the report should be designed in accordance to the following layout:
  - o **The preliminary pages**: Here the title, date, acknowledgements and foreword with the table of contents, should be mentioned.
  - o **The main text**: This should be divided into introduction, summary, main report and conclusion.
  - o **End matter**: This should contain appendices, bibliography and index.

A report should be written in a precise and objective style in simple language. Charts and illustrations should be included to lay emphasis on the study of research.

Establishing Operational Definitions

Having identified and defined the variables under study, the next step requires operationalizing the stated relationship in the form of a theoretical framework. This is an outcome of the problem audit conducted prior to defining the research problem; it can be best understood as a schema or network of the probable relationship between the identified variables. Another advantage of the model is that it clearly demonstrates the expected direction of the relationships between the concepts. There is also an indication of whether the relationship would be positive or negative.

This step however is not mandatory as sometimes the objective of the research is to explore the probable variables that might explain the observed phenomena (DV) and the outcome of the study helps to theorize and propose a conceptual model.

The theoretical framework, once formulated, is a powerful driving force behind the research process and ought to be comprehensively developed. It requires a thorough understanding of both theory and opinion.

'The specific way in which a variable is measured in a particular study is called the operational definition. It is critical to operationally define a variable in order to lend credibility to the methodology and to ensure the reproducibility of the results. Another study may measure the same variable differently. The operational definition also helps to control the variable by making the measurement constant. Therefore, when it comes to operational definitions of a variable, the more detailed the definition is, the better.'

Check Your Progress

6. When is exploratory research conducted?
7. List the ways of collecting data.

3.6 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. A variable is generally a symbol to which we assign numerals or values.
2. Descriptive hypothesis is simply a statement about the magnitude, trend or behaviour of a population under study.
3. Production management includes physical distribution of products, facility planning and manufacturing planning.
4. Exposition consists of statements that describe without attempting to explain.

NOTES

5. The results of the study must be presented in an unbiased, objective and neutral manner.
6. The researcher conducts exploratory research when the problem has not been defined or he has not gained much knowledge about the research problem.
7. The researcher can adopt one or more of the following ways to collect data:
   - By observation
   - Through personal interviews
   - Through telephone interviews
   - By mailing of questionnaires
   - Through schedules

3.7 SUMMARY

- To carry out an investigation, it becomes imperative to convert the concepts and constructs to be studied into empirically testable and observable variables.
- A variable may be dichotomous in nature, that is, it can possess only two values such as male–female or customer–non-customer.
- Variables can be further classified into five categories, depending on the role they play in the problem under consideration. These include:
  - o Dependent variable
  - o Independent variable
  - o Moderating variables
  - o Intervening variables
  - o Extraneous variables
- Any assumption that the researcher makes on the probable direction of the results that might be obtained on completion of the research process is termed as a hypothesis.
- Unlike the research problem that generally takes on a question form, the hypotheses is always in a declarative form. The statements thus formulated can lend themselves to empirical enquiry.
- A hypothesis must be measurable and quantifiable so that the statistical authenticity of the relationship can be established.
- Good business research is based on sound reasoning such as finding premises that are correct, testing the connections between their assumptions and facts, making claims that are based on adequate evidence.

NOTES

- Scientific methods are practised in business research to guide our approach to problem solving.
- Argument allows us to defend, challenge, explain, interpret and explore meaning. The two types of argument that are of great importance to research are: deductive thought and inductive thought.
- Deductive thought, also called deductive logic, is the process of reasoning from one or more general statements regarding what is known to reach a logically certain conclusion.
- On the other end of the continuum is inductive thought. Here there is no strong and absolute cause and effect between the reasons stated and the inference drawn.
- The research must have a clearly stated purpose that is implicit as when the purpose is to develop a new system of inventory management or explicit to establish quality standards for the service delivery model in our mobile eye care unit.
- The reason for a structured, ethical, justifiable and objective approach is the fact that the research carried out by us must be replicable. This means that the process followed by us must be 'reliable', i.e., in case the study is carried out under similar constraints and conditions it should be able to reveal similar results.
- The process of research is implemented as a series of actions or steps that are essentially performed in a specific order. These actions or activities usually overlap each other rather than pursuing a specific sequence.
- A hypothesis is an uncertain statement that involves the proposed answer to the problem. The hypothesis statement provides high priority to accountability and responsibility of research procedure.
- Having identified and defined the variables under study, the next step requires operationalizing the stated relationship in the form of a theoretical framework. This is an outcome of the problem audit conducted prior to defining the research problem.
- The theoretical framework, once formulated, is a powerful driving force behind the research process and ought to be comprehensively developed.

3.8 KEY WORDS

- **Objective:** It refers to something not influenced by personal feelings or opinions in considering and representing facts.
- **Deductive Reasoning:** Something that is characterized by or based on the inference of particular instances from a general law.

NOTES

- **Inductive Reasoning:** It is a method of reasoning in which the premises are viewed as supplying some evidence for the truth of the conclusion. The truth of the conclusion of an inductive argument may be probable, based upon the evidence given.
- **Proposition:** It is a statement or assertion that expresses a judgement or opinion.

3.9 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. Discuss the significance of research in the social sciences.
2. What is good business research based on?
3. List the essential tenets of the scientific method.
4. Write a short-note on inductive reasoning.
5. How is theoretical framework formulated?

Long-Answer Questions

1. Describe the various classification of variables.
2. Examine the different types of hypothesis.
3. Explain inductive and deductive reasoning in detail.
4. Discuss the features of a good research study.
5. Examine the various steps involved in the research process.

3.10 FURTHER READINGS

Creswell, John W. 2002. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. London: Sage Publications Inc.

Booth, Wayne, Gregory G. Colomb and Joseph M. Williams. 1995. *The Craft of Research*. Chicago: University of Chicago Press.

Bryman, Alan and Emma Bell. 2015. *Business Research Methods.* 4th Edition. United Kingdom: Oxford University Press.

Gupta, S.L. and Hitesh Gupta. 2012. *Business Research Methods.* New Delhi: Tata McGraw Hill Education Private Limited.

UNIT 4 PLANNING RESEARCH

NOTES

Structure

4.0 Introduction
4.1 Objectives
4.2 Research Problem
  4.2.1 Identification, Selection and Formulation of Research Problem
  4.2.2 Identification of Objectives of the Research
  4.2.3 Statement of Research Problem and Cost and Value Information
4.3 Review of Literature in the Field of Business
4.4 Answers to Check Your Progress Questions
4.5 Summary
4.6 Key Words
4.7 Self Assessment Questions and Exercises
4.8 Further Readings

4.0 INTRODUCTION

In this unit, you will learn about the planning of research. Before a research work is carried out, a lot of planning is required. Proper planning helps in performing research work with much ease. This unit focusses on the basic concept of planning a research which is essential while conducting research for a specific purpose. Ideas such as research problems are discussed. Research problems are questions that indicate gaps in the scope or the certainty of our knowledge. Discovering a problem puts the research process into action and identification of the purpose is the first step towards the solution.

4.1 OBJECTIVES

After going through this unit, you will be able to:

- Define a research problem
- Describe how a research problem is identified, selected and formulated
- Discuss review of literature in the field of business

4.2 RESEARCH PROBLEM

Research problems are questions that indicate gaps in the scope or the certainity of our knowledge. They point either to the problematic phenomena, observed events that are puzzling in terms of the accepted ideas, or to problematic theories, current ideas that are challenged by new hypothesis.

NOTES

Defining the Research Problem

Problem discovery puts the research process into action and identification of the problem is the first step towards its solution. Properly and completely defining a business problem is easier said than done. Actually, the research task may be to define or evaluate an opportunity or to clarify a problem. The definition and discovery of the research problem is viewed under this broader context. In research, often, only symptoms are apparent to begin with. The adage ‘a problem well defined is a problem half solved’ is worth remembering. The investigation gets a sense of direction with an orderly definition of the research problem. A careful attention to the problem definition allows a researcher to set the proper research objectives. When the purpose of research is clear, the chances of collecting the relevant and necessary information are greater. However, just because a problem has been discovered or an opportunity has been recognized does not mean that the problem has been defined. A problem definition indicates a specific managerial decision area to be clarified or a particular problem to be solved. It specifies research questions to be answered and the objectives of the research.

4.2.1 Identification, Selection and Formulation of Research Problem

The first and the most important step of the research process is to identify the path of enquiry in the form of a research problem. It is like the onset of a journey, in this instance the research journey, and the identification of the problem gives an indication of the expected result being sought. A research problem can be defined as a gap or uncertainty in the decision makers’ existing body of knowledge which inhibits efficient decision making. Sometimes it may so happen that there might be multiple reasons for these gaps and identifying one of these and pursuing its solution, might be the problem. As Kerlinger (1986) states, ‘If one wants to solve a problem, one must generally know what the problem is. It can be said that a large part of the problem lies in knowing what one is trying to do.’ The defined research problem might be classified as simple or complex (Hicks, 1991). Simple problems are those that are easy to comprehend and their components and identified relationships are linear and easy to understand, e.g., the relation between cigarette smoking and lung cancer. Complex problems on the other hand, talks about interrelationship between antecedents and subsequently with the consequential component. Sometimes the relation might be further impacted by the moderating effect of external variables as well, e.g., the effect

NOTES

of job autonomy and organizational commitment on work exhaustion, at the same time considering the interacting (combined) effect of autonomy and commitment. This might be further different for males and females. These kinds of problems require a model or framework to be developed to define the research approach.

Thus, the significance of a clear and well-defined research problem cannot be overemphasized, as an ambiguous and general issue does not lend itself to scientific enquiry. Even though different researchers have their own methodology and perspective in formulating the research topic, a general framework which might assist in problem formulation is given as follows:

Problem identification process

The problem recognition process invariably starts with the decision maker and some difficulty or decision dilemma that he/she might be facing. This is an action oriented problem that addresses the question of what the decision maker should do. Sometimes, this might be related to actual and immediate difficulties faced by the manager (applied research) or gaps experienced in the existing body of knowledge (basic research). The broad decision problem has to be narrowed down to information oriented problem which focuses on the data or information required to arrive at any meaningful conclusion. Given in Figure 4.1 is a set of decision problems and the subsequent research problems that might address them.

Management decision problem

The entire process explained above begins with the acknowledgement and identification of the difficulty encountered by the business manager/researcher. If the manager is skilled enough and the nature of the problem requires to be resolved by him or her alone, the problem identification process is handled by him or her, else he or she outsources it to a researcher or a research agency. This step requires the author to carry out a problem appraisal, which would involve a comprehensive audit of the origin and symptoms of the diagnosed business problem. For illustration, let us take the first problem listed in the Figure 5.1. An organic farmer and trader in Uttarakhand, Nirmal farms, wants to sell his organic food products in the domestic Indian market. However, he is not aware if this is a viable business opportunity and since he does not have the expertise or time to undertake any research to aid in the formulation of the marketing strategy, he decides to outsource the study.

NOTES

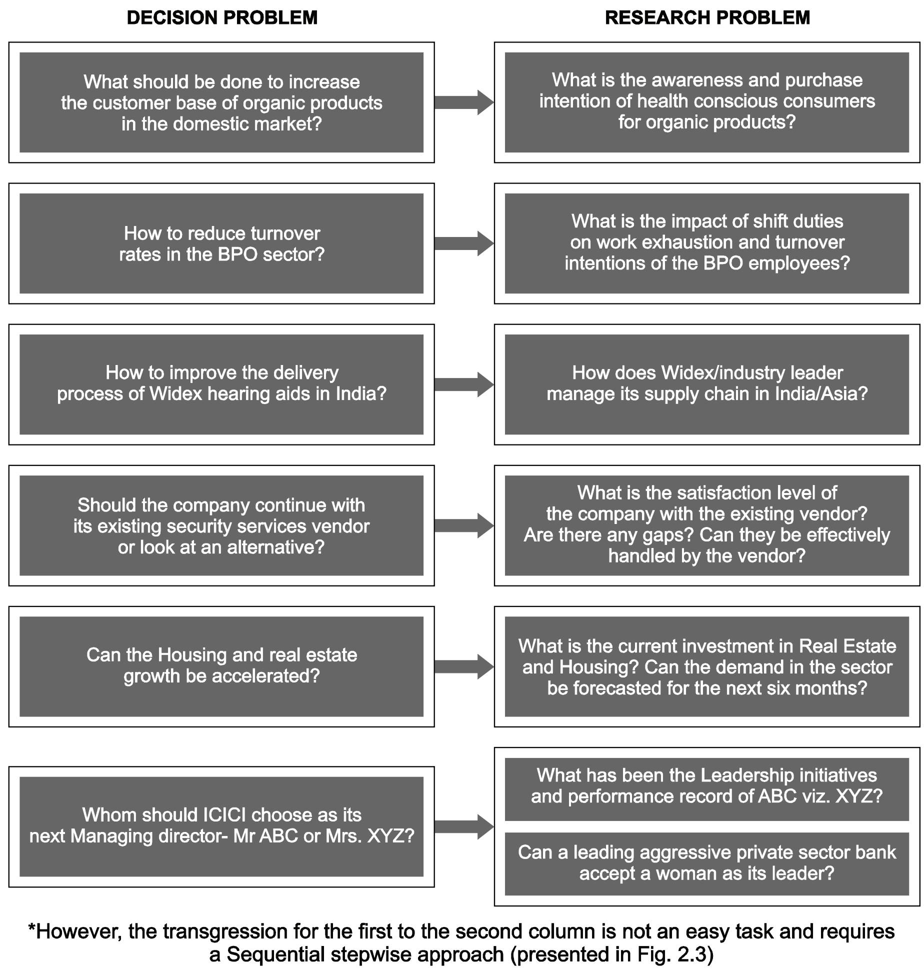


Fig. 4.1 *Converting Management Decision Problem into Research Problem*

Discussion with subject experts

The next step involves getting the problem in the right perspective through discussions with industry and subject experts. These individuals are knowledgeable about the industry as well as the organization. They could be found both within and outside the company. The information on the current and probable scenario required is obtained with the assistance of a semi-structured interview. Thus, the researcher must have a predetermined set of questions related to the doubts experienced in problem formulation. It should be remembered that the purpose of the interview is simply to gain clarity on the problem area and not to arrive at any kind of conclusions or solutions to the problem. For example, for the organic food study, the researcher might decide to go to food experts in the Ministry for Food and Agriculture or agricultural economists or retailers stocking health food as well as doctors and dieticians. This data however is not sufficient in most cases while in other cases, accessibility to subject experts might be an extremely difficult

task as they might not be available. The information should, in practice, be supplemented with secondary data in the form of theoretical as well as organizational facts.

NOTES

Review of existing literature

A literature review is a comprehensive compilation of the information obtained from published and unpublished sources of data in the specific area of interest to the researcher. This may include journals, newspapers, magazines, reports, government publications, and also computerized databases. The advantage of the survey is that it provides different perspectives and methodologies to be used to investigate the problem, as well as identify possible variables that may need to be investigated. Second, the survey might also uncover the fact that the research problem being considered has already been investigated and this might be useful in solving the decision dilemma. It also helps in narrowing the scope of the study into a manageable research problem that is relevant, significant and testable.

Once the data has been collected from different sources, the researcher must collate all information together in a cogent and logical manner instead of just listing the previous findings. This documentation must avoid plagiarism and ensure that the list of earlier studies is presented in the researcher's own words. The logical and theoretical framework developed on the basis of past studies should be able to provide the foundation for the problem statement.

The reporting should cite clearly the author and the year of the study. There are several internationally accepted forms of citing references and quoting from published sources. The *Publication Manual of the American Psychological Association* (2001) and the *Chicago Manual of Style* (1993) are academically accepted as referencing styles in management.

To illustrate the significance of a literature review, given below is a small part of a literature review done on organic purchase.

Research indicates organic is better quality food. The pesticide residue in conventional food is almost three times the amount found in organic food. Baker *et al*. (2002) found that on an average, conventional food is more than five times likely to have chemical residue than organic samples. Pesticides toxicity has been found to have detrimental effects on infants, pregnant women and general public (National Research Council, 1993; Ma *et al*., 2002; Guillete et al., 1998) Major factors that promote growth in organic market are consumer awareness of health, environmental issues and food scandals (Yossefi and Willer, 2002).

This paragraph helps justify the relevance and importance of organic versus non organic food products as well as identify variables that might contribute positively to the growth in consumption of organic products.

Organizational analysis

Another significant source for deriving the research problem is the industry and organizational data. In case the researcher/investigator is the manager himself/ herself, the data might be easily available. However, in case the study is outsourced, the detailed background information of the organization must be compiled, as it serves as the environmental context in which the research problem has to be defined. It is to be remembered at this juncture that the organizational context might not be essential in case of basic research, where the nature of study is more generic.

This data needs to include the organizational demographics—origin and history of the firm; size, assets, nature of business, location and resources; management philosophy and policies as well as the detailed organizational structure, with the job descriptions.

Qualitative survey

Sometimes the expert interview, secondary data and organizational information might not be enough to define the problem. In such a case, an exploratory qualitative survey might be required to get an insight into the behavioural or perceptual aspects of the problem. These might be based on small samples and might make use of focus group discussions or pilot surveys with the respondent population to help uncover relevant and topical issues which might have a significant bearing on the problem definition.

In the organic food research, focused group discussions with young and old consumers revealed the level of awareness about organic food and consumer sentiments related to purchase of more expensive but a healthy alternative food product.

Management research problem

Once the audit process of secondary review and interviews and survey is over, the researcher is ready to focus and define the issues of concern, that need to be investigated further, in the form of an unambiguous and clearly-defined research problem. Once again it is essential to remember that simply using the word 'problem' does not mean there is something wrong that has to be corrected, it simply indicates the gaps in information or knowledge base available to the researcher. These might be the reason for his inability to take the correct decision. Second, identifying all possible dimensions of the problem might be a monumental and impossible task for the researcher. For example, the lack of sales of a new product launch could be due to consumer perceptions about the product, ineffective supply chain, gaps in the distribution network, competitor offerings or advertising ineffectiveness. It is the researcher who has to identify and then refine the most probable cause of the problem and formalize it as the research problem. This would be achieved through the four preliminary investigative steps indicated above.

4.2.2 Identification Objectives of the Research

Let us discuss the research objectives.

NOTES

Statement of research objectives

Next, the research question(s) that were formulated need to be broken down and spelt out as tasks or objectives that need to be met in order to answer the research question.

Based on the framework of the study, the researcher has to numerically list the thrust areas of research. This section makes active use of verbs such as 'to find out', 'to determine', 'to establish', and 'to measure' so as to spell out the objectives of the study. In certain cases, the main objectives of the study might need to be broken down into sub-objectives which clearly state the tasks to be accomplished.

In the organic food research, the objectives and sub-objectives of the study were as follows:

1. *To study the existing organic market*: This would involve:
   - To categorize the organic products available in Delhi into grain, snacks, herbs, pickles, squashes and fruits and vegetables;
   - To estimate the demand pattern of various products for each of the above categories;
   - To understand the marketing strategies adopted by different players for promoting and propagating organic products.
2. *Consumer diagnostic research:* This would entail:
   - To study the existing consumer profile, i.e., perception and attitudes towards organic products and purchase and consumption patterns;
   - To study the potential customers in terms of consumer segments, level of awareness, perception and attitude towards health and organic products;
3. *Opinion survey:* To assess the awareness and opinions of experts such as doctors, dieticians and chefs in order to understand organic consumption and propagation;
4. *Retail market:* This would involve:
   - To find the gap between demand and supply for existing retailers;
   - To forecast demand estimates by considering the existing as well as potential retailers.

Thus, the research problem formulation involves the following interrelated steps:

- Ascertaining the objectives of the decision-maker
- Understanding the problem's background

NOTES

- Identifying and isolating the problem, rather than its symptoms
- Determining the unit of analysis
- Determining the relevant variables
- Stating the research objectives and research questions (hypotheses).

The above-mentioned process ensures that the real research objectives/ questions are identified for the proposed research.

4.2.3 Statement of Research Problem and Cost and Value Information

Both the decision-makers and researchers expect that the problem definition efforts should result in a statement of the research problem or research objectives. On completion of the exercise of formulating the research problem, the researcher must prepare a written statement(s) that clarifies any ambiguity about what s/he hope the research will accomplish. Writing a series of research questions and hypotheses can add clarity to the statement of the business problem. These research questions are the researcher's translation of the business problem into a specific need for inquiry; and hypothesis is an unproven proposition that tentatively explains certain facts or phenomena, a proposition that is empirically testable. In other words, research objectives/ hypotheses explain the purpose of research in measurable terms and define standards what the research should accomplish.

Values and Cost of Information

The value and cost of information play an essential role in estimating the importance of information as well as the total expenditure be done for buying the information.

Value of information

Human beings have evolved in a way that they can appreciate the role of information in their life without much effort. The initial phase in human civilization, has taught us to appreciate instinctively the importance of information and communication. We are instinctively alert to information. However, the human brain has evolved to understand that information has different degrees of 'value' (which the brain unconsciously rates). Information can be defined as processed data, which helps in decision-making and/or facilitates communication within an organization. More often, information provides answers to 'who', 'what', 'where', and 'when' type of questions. The human brain prioritizes information, according to its perceived value (most often this unconscious valuation mechanism in our brain is correct, more so in the case of instinct-based information).

For example, let us assume that a driver notices a child suddenly crossing the road and calculates that he will hit the child unless he stops and at the same time, he feels an itching sensation on his forehead. In this case,

NOTES

the brain of the driver prioritizes two different information received from different sensory inputs. It reacts by sending a signal to the driver's right foot to press the brake pedal to stop the car and only after the car stops will the brain react to the itch. We unconsciously do this every day. Evolution has taught us that information has a context and hence different degrees of value.

The principal objective of research is to find solutions to problems systematically. In general, the objectives of value of information with respect to research can be specified as follows:

- To extend the knowledge of human beings, environment, and natural phenomenon to others.
- To bring the information which is not developed fully during ordinary course of life?
- To verify existing facts and identify the changes into these existing facts.
- To develop facts for critical evaluation.
- To analyse inter-relationships between variables and deriving casual explanations.
- To develop new tools and techniques that study unknown phenomenon.
- To help in planning and development.
- To acquire familiarity with a phenomenon.
- To study the frequency of connection or independence of any activity or occurrence.
- To determine the characteristics of an individual or a group of activities and the frequency of occurrence of these activities.
- To test a hypothesis about a casual relationship that exists between variables.

The value of information is determined based on the benefits that are derived from the information. Consider an example where two products A and B are developed. The benefits derived from product A evaluates to 20 and the benefits derived from product B evaluates to 30. The difference between the benefits of the two products is 10 units.

If you add some information, the benefits derived from product A increases by 20 points from 20 to 40. The actual value of information needs to be calculated from simple mathematics. The cost of information increases by 20 units. You need to subtract the cost involved in obtaining the information, to determine the actual value of the information.

Cost of information

The cost of information determines the cost involved in obtaining the information, which includes:

NOTES

- Cost of acquiring the data.
- Cost of maintaining the data.
- Cost of generating the information.
- Cost of communicating the information.

The cost is estimated from the point the information is generated, to the point the information is retrieved. The cost of obtaining accurate and complete information is more as compared to the cost generally retrieved from the system.

4.3 REVIEW OF LITERATURE IN THE FIELD OF BUSINESS

A literature review is the presentation, classification and evaluation of what other researchers have written on a particular subject. A literature review may form part of a research thesis, or may stand alone as a separate document. Although the second of these types of literature review is less extensive than that expected for a thesis, the skills required are identical. A literature review is not simply a shopping list of what others have said. It does not and cannot refer to every piece of literature in the field. Rather, a literature review is organized according to a particular research objective. It is a conceptually organized synthesis which ultimately provides a rationale for further research, whether by you or by others. The few basic purposes that a business literature should fulfil are the following,

- Compare and contrast different authors' views on an issue
- Group authors who draw similar conclusions
- Criticize aspects of methodology
- Note areas in which authors are in disagreement
- Highlight exemplary studies
- Highlight gaps in research

Two essential elements of all literature reviews (though they are not formally identified as such) are:

1. An outline on what others have done in your chosen area
2. A progressive narrowing to the gap in the research

Economic management areas covered under literature review

The various economic areas covered under literature review are as follows:

- Economic growth and development
- Economics of organizations and industries
- Econometrics

NOTES

- Economic policy
- Economic theory
- Environmental and agricultural economics
- Financial economics
- Game theory and mathematical methods
- History of economic thought
- International economics
- Law and economics
- Monetary economics
- Industrial organization
- Public finance
- R&D and technology policy
- Regional and social policy
- Labour economics
- Population economics
- Political economy
- Development economics
- Managerial economics
- Financial psychology
- Economic geography
- Real estate economics
- Energy economics
- Green economics
- Computational economics
- Behavioural economics
- Socioeconomics

Business management areas covered under literature review

The various economic areas covered under literature review are as follows:

- Accounting
- Finance
- Strategic management
- Educational management
- Operations management
- Production management

NOTES

- Human resource management
- Marketing
- Organizational analysis and planning
- Policy making and decision making
- Ethics in business
- Motivation
- Globalization
- Training and development
- Recruitment and selection
- Industrial relations
- Virtual technology
- Change management
- Entrepreneurship
- Organizational behaviour
- Sustainable business practices
- Total quality management
- Supply chain
- Project management
- Political business strategy
- Innovation management

In a literature review, the work of others is used to cast the gap in relief (that is, to make it clear). The research question and thesis statement are then stated precisely before the remainder of the research project (refer see Appendix given at the end of this unit).

Searching for papers included two databases with a wealth of business literature: ABI/ProQuest and EBSCOhost Business Source Complete. These include peer-reviewed academic journals but also other sources, such as newspapers, magazines and trade publications.

Check Your Progress

1. What are research problems?
2. What is a literature review?
3. How is the value of information determined?
4. List three economic areas covered under literature review.

4.4 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

NOTES

1. Research problems are questions that indicate gaps in the scope or the certainity of our knowledge.
2. A literature review is a comprehensive compilation of the information obtained from published and unpublished sources of data in the specific area of interest to the researcher.
3. The value of information is determined based on the benefits that are derived from the information.
4. Three economic areas covered under literature review are as follows:
   - Economic growth and development
   - Economics of organizations and industries
   - Econometrics

4.5 SUMMARY

- Problem discovery puts the research process into action and identification of the problem is the first step towards its solution.
- The significance of a clear and well-defined research problem cannot be overemphasized, as an ambiguous and general issue does not lend itself to scientific enquiry.
- A problem definition indicates a specific managerial decision area to be clarified or a particular problem to be solved. It specifies research questions to be answered and the objectives of the research.
- Another significant source for deriving the research problem is the industry and organizational data.
- Sometimes the expert interview, secondary data and organizational information might not be enough to define the problem. In such a case, an exploratory qualitative survey might be required to get an insight into the behavioural or perceptual aspects of the problem.
- Once the audit process of secondary review and interviews and survey is over, the researcher is ready to focus and define the issues of concern, that need to be investigated further, in the form of an unambiguous and clearly-defined research problem.
- Based on the framework of the study, the researcher has to numerically list the thrust areas of research.
- The cost of information determines the cost involved in obtaining the information.

NOTES

- A literature review may form part of a research thesis, or may stand alone as a separate document. Although the second of these types of literature review is less extensive than that expected for a thesis, the skills required are identical.
- The various economic areas covered under literature review are as follows:
  - o Accounting
  - o Finance
  - o Strategic management

4.6 KEY WORDS

- **Research Problem:** It is a statement about an area of concern, a condition to be improved, a difficulty to be eliminated, or a troubling question that exists in scholarly literature, in theory, or in practice that points to the need for meaningful understanding and deliberate investigation.
- **Research Objectives:** They refer to the description of what is to be achieved by the study.
- **Audit:** It means an official inspection of an organization's accounts, typically by an independent body.
- **Hypothesis:** It refers to a supposition or proposed explanation made on the basis of limited evidence as a starting point for further investigation.
- **Thesis:** It is a statement or theory that is put forward as a premise to be maintained or proved.

4.7 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. How does the researcher define the research problem?
2. What does a literature review include?
3. List the economic areas covered under literature review.

Long-Answer Questions

1. Examine how the research problem is identified, selected and formulated.
2. Discuss review of literature in business.
3. Describe how research objectives are identified.

4.8 FURTHER READINGS

NOTES

Creswell, John W. 2002. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. London: Sage Publications Inc.

Booth, Wayne, Gregory G. Colomb and Joseph M. Williams. 1995. *The Craft of Research*. Chicago: University of Chicago Press.

Bryman, Alan and Emma Bell. 2015. *Business Research Methods.* 4th Edition. United Kingdom: Oxford University Press.

Gupta, S.L. and Hitesh Gupta. 2012. *Business Research Methods.* New Delhi: Tata McGraw Hill Education Private Limited.

BLOCK - II

SAMPLING AND ITS TYPES

NOTES

UNIT 5 ECONOMIC MANAGEMENT

Structure

5.0 Introduction
5.1 Objectives
5.2 Use in Identifying Research Gaps and Techniques
5.3 Hypothesis: Meaning, Sources, Types of Hypothesis, and Hypothesis Testing
5.4 Research Design
 5.4.1 Factors Affecting Research Design
 5.4.2 Evaluation of Research Design
5.5 Answers to Check Your Progress Questions
5.6 Summary
5.7 Key Words
5.8 Self Assessment Questions and Exercises
5.9 Further Readings

5.0 INTRODUCTION

In this unit, you will learn about economic management and hypothesis. According to Theodorson, 'a hypothesis is a tentative statement asserting a relationship between certain facts.' Kerlinger describes it as 'a conjectural statement of the relationship between two or more variables'. Hypothesis is more useful when stated in precise and clearly defined terms. A good hypothesis implies that hypothesis which fulfils its intended purposes and is up to the mark. The unit will go on to discuss research design.

It has been found by research scholars and managers alike that most research studies do not result in any significant findings because of a faulty research design. Most researchers feel that once the problem is defined and hypotheses are made, one can go ahead and collect the data on a specified group, or sample, and then analyse it using statistical tests. However, unless the formulated research problem and the study hypotheses is tested through a well-defined plan, answers are going to be based on hit and trial rather than any sound logic.

The design approaches available to the researcher are many and will depend on whether the study is of descriptive or conclusive nature. The designs range from very simple, loosely structured to highly scientific experimentation. Just as experiments in science, in business research also there are chances of error and this needs to be understood and controlled for more accurate results for the decision-maker.

5.1 OBJECTIVES

NOTES

After going through this unit you will be able to:

- Discuss research gaps
- Describe the different types of hypothesis testing
- Explain the various steps in a research design

5.2 USE IN IDENTIFYING RESEARCH GAPS AND TECHNIQUES

When a researcher is working on original research, he would like to identify a need for his research somewhere close to the beginning of his paper. Why is it so? Because he would like to show the reader that he is not duplicating existing research. He does this by surveying the current research and then identifying a gap that he is going to fill. The researcher identifies the broad problem and states its importance. He also states what is significant in what has already been written. He describes the gap he proposes to fill in the existing research literature. This then creates an opportunity for him to make a contribution to the research in the area.

Thus, the process of developing a research proposal is ultimately one of establishing a gap in current research which the researcher aims to address. As a result, the function of the researcher's research proposal and the literature review chapter of his thesis is to convince the audience that this research gap does exist, and that his research is valid and significant. The principle aim of the researcher is to assess the gaps in research with respect to his area of research, review current work being carried out in relation to these gaps, and recommend the most fruitful areas for his.

The characteristics of research gap may be summarized as follows:

- It is what makes the researcher's manuscript publishable.
- It is the missing element in the existing research literature.
- It is the gap that the researcher will fill with his research approach.

5.3 HYPOTHESIS: MEANING, SOURCES, TYPES OF HYPOTHESIS, AND HYPOTHESIS TESTING

The term 'hypothesis' is derived from the ancient Greek term *hypotithenai* which means to put under or to suppose. There are several characteristics of hypotheses, which are as follows:

NOTES

- **Clear and accurate**: A hypothesis should be clear and accurate to be able to draw a consistent conclusion.
- **Statement of relationship between variables**: If a hypothesis is relational, it should state the relationship between the different variables.
- **Testability**: A hypothesis should be open to testing so that other deductions can be made from it and can be confirmed or disproved by observation. The researcher should do some prior study to make the hypothesis testable.
- **Specific with limited scope**: A hypothesis which is specific with limited scope is more easily testable than a hypothesis with limitless scope. Therefore, a researcher should spend more time to conduct research on such a kind of hypothesis.
- **Simplicity**: A hypothesis should be stated in the most simple and clear terms to make it understandable.
- **Consistency**: A hypothesis should be reliable and consistent with established facts.
- **Time limit**: A hypothesis should be capable of being tested within a reasonable time. In other words, the excellence of a hypothesis is judged by the time taken to collect the data needed for the test.
- **Empirical reference**: A hypothesis should explain or support all the sufficient facts needed to understand what the problem is all about.

Hypothesis Testing: Parametric and Non-Parametric Tests

Hypothesis testing means to determine whether or not the hypothesis is appropriate. This involves either accepting or rejecting a null hypothesis. The researcher has to pursue certain activities contained in the procedure of hypothesis.

Hypotheses: Null and Alternative

A **hypothesis** is an approximate assumption that a researcher wants to test for its logical or empirical consequences. A hypothesis refers to a provisional idea whose merit needs evaluation, but has no specific meaning. It is often referred to as a convenient mathematical approach for simplifying a cumbersome calculations. Setting up and testing hypotheses is an integral art of statistical inference. Hypotheses are often statements about population parameters like variance and expected value. During the course of hypothesis testing, some inferences about the population like mean and proportion are made. Any useful hypothesis will enable predictions by reasoning, including deductive reasoning. A hypothesis might predict the outcome of an experiment in a lab setting involving the observation of a phenomenon in nature. Thus, a

hypothesis is an explanation of a phenomenon proposal suggesting a possible correlation between multiple phenomena.

For the purpose of decision-making, a hypothesis has to be verified and then accepted or rejected. This is done with the help of observations. Decision-making plays a significant role in different areas such as marketing, industry and management. Testing a statistical hypothesis on the basis of a sample enables us to decide whether the hypothesis should be accepted or not. The sample data enables us to accept or reject the hypothesis.

Null Hypothesis and Alternative Hypothesis

In the context of statistical analysis and research, while comparing any two methods, the following concepts or assumptions are taken into consideration:

- **Null Hypothesis**: While comparing two different methods in terms of their superiority, wherein the assumption is that both the methods are equally good is called null hypothesis. It is also known as statistical hypothesis and is symbolized as H_0.
- **Alternate Hypothesis**: While comparing two different methods regarding their superiority, wherein, stating a particular method to be good or bad as compared to the other one is called alternate hypothesis. It is symbolized as H_1.

Note 1: A test provides evidence, if any, against a hypothesis, usually called a null hypothesis. The test cannot prove the hypothesis to be correct. It can give some evidence against it.

The test of hypothesis is a procedure to decide whether to accept or reject a hypothesis.

Note 2: The acceptance of hypotheses implies that if there is no evidence from the sample, we should believe otherwise.

The rejection of a hypothesis leads us to conclude that it is false. This way of putting the problem is convenient because of the uncertainty inherent in the problem. In view of this, we must always briefly state a hypothesis that we *hope to reject.* A hypothesis stated in the hope of being rejected is called a *null hypothesis* and is denoted by H_0.

If H_0 is rejected, it may lead to the acceptance of an alternative hypothesis denoted by H_1.

To take an example, suppose a new fragrant soap is introduced in the market. The null hypothesis H_0, which may be rejected, is that the new soap is not better than any existing soap.

Similarly, a dice is suspected to be rolled. Roll the dice a number of times to test.

By the Null Hypothesis H_0, $p = 1/6$ for showing six.

By the Alternative Hypothesis H_1, $p \neq 1/6$.

A hypothesis is usually considered the principal instrument in research. The basic concepts regarding the testability of a hypothesis are now discussed.

Comparison of Null Hypothesis and Alternate Hypothesis

Following are the points of comparison between the null hypothesis and alternate hypothesis:

- Null hypothesis is always specific while alternate hypothesis gives an approximate value.
- The rejection of null hypothesis involves great risk, which is not the case with alternate hypothesis.
- Null hypothesis is more frequently used in statistics than alternate hypothesis because it is specific and is not based on probabilities.

Procedure for hypothesis testing

The procedure for hypothesis testing is as follows:

1. **Making formal statement**: In this step, the nature of a hypothesis is clearly stated, which could be either null hypothesis or alternate hypothesis. Stating a problem in hypothesis testing is of utmost importance, which should be done with proper care, keeping in mind the object and nature of the problem.
2. **Choosing a significance level**: In this step, a hypothesis is tested on the basis of a present significance level, which has to be adequate in terms of nature and purpose of the problem.
3. **Sampling distribution**: In this step, determining an appropriate sampling distribution and making a choice between normal distribution and t-distribution are included.
4. **Random selection of a sample**: In this step, a random sample is selected from the sample data for determining an apt value.
5. **Probability calculation**: In this step, the probability regarding viability of the sample result is made dependent on the null hypothesis.
6. **Comparison:** In this step, the calculated probability and the value of alpha in case of one-tailed test and alpha/2 in case of two-tailed test is compared.

Check Your Progress

1. What is the process of developing a research proposal?
2. What is null hypothesis?

5.4 RESEARCH DESIGN

Research design is a structure that gives an outline of the overall research work. It is the result of better planning and implementation of a good strategy. Different authors have given different definitions of a research design. According to Kerlinger, research design is the plan, structure and strategy of investigation conceived so as to obtain answers to research questions and to control variance. Bernard Phillips defines research design as the blueprint for collection, measurement and analysis of data.

Green *et al*. (2008) defines research designs as 'the specification of methods and procedures for acquiring the information needed. It is the overall operational pattern or framework of the project that stipulates what information is to be collected from which sources by what procedures. If it is a good design, it will insure that the information obtained is relevant to the research questions and that it was collected by objective and economical procedures.'

The decisions that you need to take to formulate a research design should be based on the following questions:

- What is the research all about?
- Why is the research being done?
- What kind of data is required for the research?
- From where can the data be obtained?
- How much time will the research take?
- What is a sample research design?
- How should the data be analysed?
- What is the style of report preparation?

A research design helps a researcher to organize ideas and check for flaws and inadequacies in the collected data. It involves the following elements:

- A statement that clearly defines the problem for which the research is being done
- Procedures and techniques for gathering the information required for research design
- Methods that need to be implemented for processing and analysing the data required for research design

The overall research design can be divided into the following four parts:

- **Sampling part:** It includes the method of selecting items that are to be observed for the research study.

NOTES

- **Observational part:** It includes the conditions under which you need to make observations.
- **Statistical part:** It is based on the number of items that need to be observed and the analysis technique to be used for the analysis of gathered data.
- **Operational part:** It involves the techniques that help to implement the items specified in the sampling, statistical and observational designs.

Need for research design

Before starting the research process, the formulation of an efficient and appropriate research design is important. A research design is significant as it has the following advantages:

- It helps in the smooth functioning of various research operations.
- It requires less effort, time and money.
- It helps to decide the methods and techniques to be used for collecting and analysing data.

The researcher needs to consider the following factors before creating a research design:

- Source of the information
- Skills of the researcher and his coordinating staff
- Problem objectives
- Nature of the problem
- Availability of time and money for the research work

Features of a good research design

A good research design is characterized by flexibility, efficiency and low cost, but it has many other features too. On the basis of the description of the design, a research design has the following features:

- It states the sources and types of information required for solving the problem for which the research is being carried out.
- It is a strategy for indicating the approach to be adopted for gathering and analysing data.
- It includes performing research work according to time and budget constraints.
- It minimizes preconception and maximizes the reliability of collected and analysed data.
- It minimizes experimental errors in an investigation.
- It provides various aspects for dealing with a problem.

A research design depends to a large extent on the type of research study that you are conducting. If the research study is exploratory, then major emphasis is on the discovery of ideas. So, a research design should be flexible to implement the different aspects of a phenomenon. However, when the purpose is to obtain an accurate description of a research study, the design that maximizes reliability of the collected data is considered a good design. The availability of time, money, skills of the research staff and the method of obtaining information must be considered while creating experimental design, survey design and sample design.

Steps in research design

The steps in a research design primarily depend on the type of research being conducted. The steps involved in a research process are as follows:

1. Preparing the research question or problem
2. Assessing the available literature
3. Creating hypotheses
4. Constructing the research design
5. Collecting data
6. Analysing the data
7. Interpreting the results
8. Writing the research report

The fourth step, i.e., constructing the research design, involves three subordinate steps, which include the process of creating a research design. The three subordinate steps can further be explained as follows:

(i) **Identifying variables**: This involves identifying the variables to be studied and determining their types. The most common types of variables are dependent, independent, controlled and other variables. Dependent variables are items such as responses of subjects and outcomes of survey or criterion variables. Independent variables, on the other hand, are those, which are explanatory or predictor variables.

(ii) **Formulating functional definitions**: Here, the researcher explores the possibilities and the ways in which the variables can be operationalized.

(iii) **Selecting design for data analysis**: This is the preliminary step of data collection, and hence, involves determination of what design option to choose for analysing the data being collected.

Types of Research Design

Several research designs are classified on the basis of the study performed in the research. These research designs can be listed as follows:

NOTES

- Research design in exploratory research studies
- Research design in descriptive studies
- Research design in quantitative studies
- Research design in qualitative studies
- Research design in experimental research studies

1. Exploratory Research Design

Exploratory research design is also known as formulative research design. In this research design, a specific subject is investigated. It helps to generate a set of hypotheses or research-based questions that can be used at a later stage. The three methods that are applied for explorative research studies are as follows:

- **Surveying the literature**: It is the simplest method for formulating the research problem in which along with new literature, previous hypotheses are reviewed and evaluated for future research.
- **Experience survey**: It is a type of research that involves practically experienced persons in the research work. For such a survey, people with more innovative ideas are carefully selected as respondents and then the investigators interview the respondents. Thus, experience survey enables the researcher to concisely define the problem. This survey also provides information about the practical possibilities for different research works.
- **Analysis of insight-stimulating examples**: It includes an intensive study of selected instances of a phenomenon. In this method, the attitude of the investigator, intensity of study and ability of the researcher are required to unify the diverse information of the problem.

Thus, in exploratory research study, the applied method needs to be flexible, regardless of the type of the method, so that the different aspects of the problem can be considered. In exploratory research design, the following considerations are kept in mind:

- A small sample size is used.
- Data requirements are unclear.
- General objectives are considered, rather than specific objectives.
- No definite suggestions are made after research analysis.

2. Descriptive Research Design

A descriptive research study describes the characteristics of a particular problem or an individual or a group. Descriptive studies include specific predictions concerned with study, facts and characteristics concerning an individual, a group or situations. Most of the social research is based on

descriptive research studies. In descriptive studies, the questions related to 'what', 'why', 'where' and 'who' need to be answered.

The following steps must be followed while designing a descriptive study:

1. **Formulating the objectives of the study:** This step specifies the objectives to ensure that the collected data is related to the study, otherwise the research will not provide the desired result.
2. **Designing the data collection methods:** This step helps to select the method, that is, observation, questionnaires, interview or examination of records, for collecting the data.
3. **Processing and analysing the data:** The data collected for the research study must be processed and analysed. This includes analysing the data collected through interviews and observations, tabulating the data and performing statistical computations.
4. **Reporting the researched data:** For reporting the findings, the layout should be well planned, and presented in a simple and effective style.

   In descriptive studies, the following considerations should be kept in mind:

   - The phenomenon under study should be described.
   - The data may be related to the behavioural variables of the respondent.
   - The recommendations are definite.
   - The objectives should be specific, data requirements should be clear and large samples should be used.

Descriptive research design requires a clear specification of 'when', 'where', 'who', 'what', 'why', and 'how' of the research. Its main purpose is to describe the characteristics or the function. Some of the conditions in which this research can be recommended are:

- To make a specific forecast
- Discovery of associations among variables
- Estimates of the proportions of a population that have some specific characteristics.
- To describe the characteristics of product, group, organization or market.

Unlike exploratory research, the descriptive research design is marked by a specific hypotheses, clear statement of the problem and detailed information needs. Generally, descriptive research follows surveys, panels, secondary data analysis and observation methods and can be classified into cross-sectional and longitudinal research.

NOTES

Cross-sectional research: This is the most frequently used research design in business research and involves information collection from a given sample of population elements, and that too only once. They may be either multiple cross-sectional or single cross-sectional. In single cross-sectional designs, only one sample of respondents is drawn from the target population, and the information from this sample is obtained only once. This design is also referred to as sample survey research design.

In multiple cross-sectional design, there are two or more samples of respondents, and the information from each of the sample is obtained only once. Often, information from different samples is obtained at different times over long intervals. Multiple cross-sectional designs allow comparisons at the aggregate level but not at the individual respondent level. Because a different sample is taken each time, a survey is conducted, there is no way to compare the measures on an individual respondent across surveys. One of the special interest, multiple cross-sectional design is cohort analysis, which consists of a series of surveys conducted at appropriate time intervals, where the cohort serves as the basis unit of analysis. A group of respondents who experience the same event within the same time interval is referred to as a 'cohort'.

Longitudinal research design: Unlike cross-sectional research design, a fixed sample(s) of population elements is measured repeatedly on the same variable. In other words, the same objects are studied over time and the same variables are measured. In contrast to the cross-sectional design, which provides a snapshot of the variables of interest at a single point in time, a longitudinal study gives a series of pictures that provide an in-depth view of the situation and the changes that have taken place over time. Sometimes, the term panel is used interchangeably with the term longitudinal design. A panel consists of a sample of respondents who have agreed to give information at specified intervals over an extended period.

Causal research design: This research design is used to obtain the evidence of cause-and-effect (causal) relationships. Like descriptive research design, causal research design also requires a plan and structure and is more appropriate for the following purposes:

- To understand cause (independent) variables and effect (dependent) variables of the phenomenon
- To determine the nature of the relationship between cause and effect variables to make predictions about effect

In this design, causal (independent) variables are manipulated in a relatively controlled environment, in which the other variables that may affect the dependent variable are controlled or checked as much as possible. The effect of this manipulation on one or more dependent variables is then measured to infer causality. The main method of causal research is experimentation.

NOTES

3. Diagnostic/Conclusive Research Design

A conclusive research design is more structured and formal than an exploratory research design. It is based on large representative samples, and the data obtained is subjected to quantitative analysis. The aim of conclusive research is to examine specific relationships and test specific hypotheses. To achieve these objectives, the researcher needs to clearly specify the required information. In this research, the findings are considered as conclusive in nature as they are used as inputs for managerial decision-making. The two categories of conclusive research designs are descriptive and causal. Descriptive research designs can further be either cross-sectional or longitudinal.

4. Experimental Research Design

Experimental research design is usually applicable when we are determining the cause and effect relationship or deriving the cause and effect inferences in any experimental research study. Experimental research design is instrumental in answering some of the important psychological questions that are based on the concept of what causes what.

The objective of experimental research design is to establish the cause and effect relationship between variables. The four types of variables related to experimental research design are as follows:

- **Independent variables:** These signify conditions or measures in the experimental design that can be changed.
- **Dependent variables:** These variables can be measured and signify the effect or result in the experimental design.
- **Control variables:** These remain constant in the experimental design.
- **Random variables:** These can vary their values in different conditions in the experimental design.

There are many variations in experimental designs, which are created to achieve different results and resolve different problems. We can define the simplest form of experimental design by creating two similar groups, which are equivalent to each other in all respects, except for the fact that one group will receive the treatment and another group will not receive the treatment. The group that receives the treatment can be termed as the treatment group and the group that does not receive the treatment can be termed as the comparison or control group.

The formation of two similar groups that are equivalent to each other is ensured by randomly assigning people or participants into two groups from a common pool of people or participants. The success of the experiment is based on the concept of random assignment of people into two groups. However, as two people cannot be exactly similar, in the experimental design, we refer to

the idea of probability and say that two groups are probabilistically equivalent or equivalent in the probabilistic ranges.

5.4.1 Factors Affecting Research Design

NOTES

Some of the factors that affect research design are as follows:

- Accessibility of scientific information
- Availability of sufficient data, time, money and manpower
- Exposure to various sources of data
- Extent of the problem that needs to be resolved with the help of research
- Support of the top management of the company or organization
- Knowledge, skills and ability of the researcher

5.4.2 Evaluation of Research Design

Following points need to be considered for evaluating research design

- Determining the nature of the research that needs to be evaluated
- Checking the relevance and reliability of the sources that are cited in the research proposal
- Checking whether the research design conforms to the standards of scientific research
- Identifying whether the research design is semi-experimental, experimental, descriptive or correlational
- Finding the ethical problems that may arise in the research design
- Reviewing existing literature to find out if similar or same research has been done before

Check Your Progress

3. How does Bernard Phillips define research design?
4. List the steps in the research process.
5. What is the objective of experimental research design?
6. List two factors that affect research design.

5.5 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. The process of developing a research proposal is ultimately one of establishing a gap in current research which the researcher aims to address.

2. While comparing two different methods in terms of their superiority, wherein the assumption is that both the methods are equally good is called null hypothesis. It is also known as statistical hypothesis and is symbolized as H_0.
3. Bernard Phillips defines research design as the blueprint for collection, measurement and analysis of data.
4. The steps involved in a research process are as follows:
   (i) Preparing the research question or problem
   (ii) Assessing the available literature
   (iii) Creating hypotheses
   (iv) Constructing the research design
   (v) Collecting data
   (vi) Analysing the data
   (vii) Interpreting the results
   (viii) Writing the research report
5. The objective of experimental research design is to establish the cause and effect relationship between variables.
6. Two factors that affect research design are as follows:
   - Accessibility of scientific information
   - Availability of sufficient data, time, money and manpower

5.6 SUMMARY

- When a researcher is working on original research, he would like to identify a need for his research somewhere close to the beginning of his paper.
- The researcher identifies the broad problem and states its importance. He also states what is significant in what has already been written. He describes the gap he proposes to fill in the existing research literature.
- The term 'hypothesis' is derived from the ancient Greek term hypotithenai which means to put under or to suppose.
- A hypothesis should be open to testing so that other deductions can be made from it and can be confirmed or disproved by observation. The researcher should do some prior study to make the hypothesis testable.
- A hypothesis refers to a provisional idea whose merit needs evaluation, but has no specific meaning.
- The rejection of a hypothesis leads us to conclude that it is false. This way of putting the problem is convenient because of the uncertainty inherent in the problem.

NOTES

- Research design is a structure that gives an outline of the overall research work. It is the result of better planning and implementation of a good strategy.
- A good research design is characterized by flexibility, efficiency and low cost, but it has many other features too.
- Several research designs are classified on the basis of the study performed in the research. These research designs can be listed as follows:
  - Research design in exploratory research studies
  - Research design in descriptive studies
  - Research design in quantitative studies
  - Research design in qualitative studies
  - Research design in experimental research studies

5.7 KEY WORDS

- **Research Gap:** It is a research question or problem which has not been answered appropriately or at all in a given field of study.
- **Random Selection:** It refers to how sample members (study participants) are selected from the population for inclusion in the study.
- **Sample Distribution:** It is a probability distribution of a statistic obtained through a large number of samples drawn from a specific population.
- **Research Design:** It is the set of methods and procedures used in collecting and analyzing measures of the variables specified in the research problem research.

5.8 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. What are the characteristics of the research gap?
2. Discuss the characteristics of a hypothesis.
3. What are the different parts of the research design?

Long-Answer Questions

1. Explain null and alternative hypothesis.
2. What is hypothesis testing? Discuss its procedure.
3. Examine the various types of research design.

5.9 FURTHER READINGS

Creswell, John W. 2002. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. London: Sage Publications Inc.

Booth, Wayne, Gregory G. Colomb and Joseph M. Williams. 1995. *The Craft of Research*. Chicago: University of Chicago Press.

Bryman, Alan and Emma Bell. 2015. *Business Research Methods.* 4th Edition. United Kingdom: Oxford University Press.

Gupta, S.L. and Hitesh Gupta. 2012. *Business Research Methods.* New Delhi: Tata McGraw Hill Education Private Limited.

UNIT 6 SAMPLING DESIGN

NOTES

Structure

6.0 Introduction
6.1 Objectives
6.2 Meaning of Sampling Design
6.2.1 Principle of Sampling and Essentials of Good Sampling
6.2.2 Sampling Concepts and Sampling Frame
6.3 Census Method and Sampling Method for Investigation
6.4 Answers to Check Your Progress Questions
6.5 Summary
6.6 Key Words
6.7 Self Assessment Questions and Exercises
6.8 Further Readings

6.0 INTRODUCTION

In the previous unit, you learnt about the economic management and hypothesis. In this unit, we will turn towards sampling design.

While conducting a research, collecting a sample is of utmost importance. However, simply collecting a sample is not enough. There is a certain plan for obtaining a sample from the sampling frame. Proper planning and designing is very much essential for carrying out a survey. This unit focuses on the importance of sample design; its principles, essentials of good sampling and various methods involved in an investigation. Sampling design refers to the technique or procedure adopted by a researcher in selecting some samples or sampling units from where inferences about population are drawn.

6.1 OBJECTIVES

After going through this unit, you will be able to:

- Discuss the essentials of good sampling
- Evaluate the need for sampling
- Analyse the census method and sampling method

6.2 MEANING OF SAMPLING DESIGN

Sampling design refers to a definite plan for obtaining a sample from the sampling frame. It refers to the technique or procedure, which a researcher adopts in selecting some sampling units from where inferences about population are drawn. Sampling data is obtained before collecting the final data.

NOTES

Need for Sampling

We can define sampling as the process of obtaining information about an entire population by examining only a part of it. Sampling is required for the following reasons:

- It saves time and money. A sample study is usually less expensive than a census study.
- It produces results at a faster speed.
- It enables more accurate measurement for a sample study as it is conducted by experienced investigators.
- It is the only method for an infinitely large population.
- It usually enables you to estimate sampling errors and thus assists you in obtaining information concerning some characteristics of the population such as age group or gender.

The advantages of sampling are as follows:

- The solution to know the true or actual values of the various parameters of the population would be to take into account the entire population. This is not feasible due to the cost and time involved. Therefore, sampling seems more economical.
- As the magnitude of operation involved in a sample survey is small, the execution of the fieldwork and the analysis of results can be carried out at a faster rate and in a lesser time.
- Only a small staff is required for gathering and analysing information and preparing reports. Therefore, sampling is a very cheap process.
- A researcher can collect detailed information in a lesser time than is possible in a census survey.
- As the scale of operation involved in a sample survey is small, the quality of interviews supervision and other related activities is better than the census survey.
- Sampling provides adequate information needed for the purpose and is sufficiently reliable for surveys.

Characteristics of Sampling

Usually, sampling involves determining a property or attribute to adhere to for the purpose of differentiating between items of a given population. These attributes, which are the objects of study, are called characteristics. The process of distinguishing the items is usually of two types, quantitative or qualitative. In quantitative sampling, characteristics pertaining to variables are dealt with. On the other hand, qualitative sampling is concerned with the characteristics related to attributes.

NOTES

The basic idea behind sampling is to use the common characteristics of average items as samples for a larger entity. Thus, it involves choosing a subset of population elements for study. Thus, for example, if the population to be dealt with is, say that of roads, then the characteristics could be length, duration, roughness, carriage capacity, etc. Sampling proves to be a much cheaper and quicker mode of estimation where the population is absolutely huge.

However, it is absolutely necessary to take ample care while determining which characteristics should be sampled. Those characteristics, which are rare, should be avoided. Similarly, even if there are certain very common characteristics, which, however, do not contribute in any way to draw reliable estimates, then such characteristics should not be sampled.

6.2.1 Principle of Sampling and Essentials of Good Sampling

After understanding various concepts related to sampling and sampling design, let us now look at the principles and essentials of sampling:

- **Unbiased**: One of the primary principles of sampling is that it should not be biased.
- **Adequate sampling size:** For accurate sampling, it is important that the size of sample is adequate.
- **Standardized samples:** Samples should be standardized so that they can be checked for relevance and accuracy.
- **Statistical Regularity:** According to this principle, the units of the sample must be selected at random.

Uses of sampling in real life

In our day-to-day life we make use of the concept of sampling. There is hardly any person who has not made use of the concept in a real-life situation. Consider the following examples:

- Suppose you go to a grocery shop to purchase rice. You have been instructed by your mother to purchase good quality rice. On reaching the grocery shop you have the choice of buying the rice from any one of three bags. What is generally done is that you pick up a handful of rice from each bag, examine its quality and then decide about which bag's rice is to be bought. The concept of sampling is being used here as a handpick from each bag is a sample and examining the quality is a process by which you are trying to assess the quality of all the rice in the bag.
- Suppose you have a guest for dinner at your residence. Your mother prepares a number of dishes and before the guest arrives, she may give you a tablespoon of each of the dish to taste and tell her whether all the ingredients are in the right proportion or not. Again, a sample is being taken from each of the dish to know how each of them tastes.

- You go to a bookshop to buy a magazine. Before you decide to buy it, you may flip through its pages to know whether the contents of the magazines are of interest to you or not. Again, a sample of pages is taken from the magazine.

NOTES

6.2.2 Sampling Concepts and Sampling Frame

Before we get into the details of various issues pertaining to sampling, it would be appropriate to discuss some of the sampling concepts.

Population: Population refers to any group of people or objects that form the subject of study in a particular survey and are similar in one or more ways. For example, the number of full-time MBA students in a business school could form one population. If there are 200 such students, the population size would be 200. We may be interested in understanding their perceptions about business education. If there are 200 class IV employees in an organization and we are interested in measuring their job satisfaction, all the 200 class IV employees would form the population of interest. If a TV manufacturing company produces 150 TVs per week and we are interested in estimating the proportion of defective TVs produced per week, all the 150 TVs would form our population. If, in an organization there are 1000 engineers, out of which 350 are mechanical engineers and we are interested in examining the proportion of mechanical engineers who intend to leave the organization within six months, all the 350 mechanical engineers would form the population of interest. If the interest is in studying how the patients in a hospital are looked after, then all the patients of the hospital would fall under the category of population.

Element: An element comprises a single member of the population. Out of the 350 mechanical engineers mentioned above, each mechanical engineer would form an element of the population. In the example of MBA students whose perception about the management education is of interest to us, each of the 200 MBA students will be an element of the population. This means that there will be 200 elements of the population.

Sampling frame: Sampling frame comprises all the elements of a population with proper identification that is available to us for selection at any stage of sampling. For example, the list of registered voters in a constituency could form a sampling frame; the telephone directory; the number of students registered with a university; the attendance sheet of a particular class and the payroll of an organization are examples of sampling frames. When the population size is very large, it becomes virtually impossible to form a sampling frame. We know that there is a large number of consumers of soft drinks and, therefore, it becomes very difficult to form the sampling frame for the same.

Sample: It is a subset of the population. It comprises only some elements of the population. If out of the 350 mechanical engineers employed in an organization, 30 are surveyed regarding their intention to leave the

NOTES

organization in the next six months, these 30 members would constitute the sample.

Sampling unit: A sampling unit is a single member of the sample. If a sample of 50 students is taken from a population of 200 MBA students in a business school, then each of the 50 students is a sampling unit. Another example could be that if a sample of 50 patients is taken from a hospital to understand their perception about the services of the hospital, each of the 50 patients is a sampling unit.

Sampling: It is a process of selecting an adequate number of elements from the population so that the study of the sample will not only help in understanding the characteristics of the population but will also enable us to generalize the results. We will see later that there are two types of sampling designs—probability sampling design and non-probability sampling design.

Census (or complete enumeration): An examination of each and every element of the population is called census or complete enumeration. Census is an alternative to sampling. We will discuss the inherent advantages of sampling over a complete enumeration later.

Check Your Progress

1. What is 'sample design'?
2. State any one advantage of sampling.
3. What is a sampling unit?

6.3 CENSUS METHOD AND SAMPLING METHOD FOR INVESTIGATION

In a research study, we are generally interested in studying the characteristics of a population. Suppose in a town there are 2 lakh households and we are interested in estimating the proportion of those households who spend their summer vacations in a hill station. This information can be obtained by asking every household in that town. If all the households in a population are asked to provide information, such a survey is called a census. There is an alternative way of obtaining the same information by choosing a subset of all the two lakh households and asking them for the same information. This subset is called a sample. Based upon the information obtained from the sample, a generalization about the population characteristic could be made. However, that sample has to be representative of the population. For a sample to be a representative of the population, the distribution of sampling units in the sample has to be in the same proportion as the elements in the population. For

NOTES

example, if in a town there are 50, 35 and 15 per cent households in lower, middle and upper income groups, then a sample taken from this population should have the same proportions in for it to be representative. There are several advantages of sample over census.

- Sample saves time and cost. Consider as an example that we are interested in estimating the monthly average household expenditure on food items by the people of Delhi. It is known that the population of Delhi is approximately 1.2 crore. Now, if we assume that there are five members per household, it would mean that the population comprises approximately 24 lakh households. Collecting data on the expenditure of each of the 24 lakh households on food items would be a very time-consuming and expensive exercise. This is because you will need to hire a number of investigators and train them before you conduct the survey on the 24 lakh households. Instead, if a sample of, say, 2000 households is chosen, the task would not only be finished faster but will be in expensive, too.
- Many times a decision-maker may not have too much of time to wait till all the information is available. Therefore, a sample could come to his rescue.
- There are situations where a sample is the only option. When we want to estimate the average life of fluorescent bulbs, what is done is that they are burnt out completely. If we go for a complete enumeration there would not be anything left for use. Another example could be testing the quality of a photographic film. To test the quality, we need to expose it completely and the moment it is exposed it gets destroyed. Therefore, sample is the only choice.
- The study of a sample instead of complete enumeration may, at times, produce more reliable results. This is because by studying a sample, fatigue is reduced and fewer errors occur while collecting the data, especially when a large number of elements are involved.

A census is appropriate when the population size is small, e.g., the number of public sector banks in the country. Suppose the researcher is interested in collecting information from the top management of a bank regarding their views on the monetary policy announced by the Reserve Bank of India (RBI), in this case, a complete enumeration may be possible as the population size is not very large. As another example, consider a business school having a few students from Europe, East Africa, South East Asia and the Middle East. These students would have their own problems in settling down in the Indian environment because of the differences in social, cultural and environmental factors. To understand their concerns, a survey of population may be more appropriate. Therefore, a survey of population

could be used when there is a lot of heterogeneity in the variables of interest and the population size is small.

Methods of Sampling

NOTES

Sampling is important as the researcher has to collect data from all cases. There are different types of sampling techniques/ methods which researcher needs to understand before selecting the proper sampling method for the research. Generally, a market research study requires two essential types of sampling, namely probability sampling and non-probability sampling which will be discussed in detail in the next unit.

Check Your Progress

4. State any one advantage of sample over census.
5. When is census appropriate?

6.4 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. A definite plan for obtaining a sample from the sampling frame is known as sample design. It also encompasses the technique, adopted by a researcher in selecting some sampling units to carry out an investigation.
2. Any one advantage of sampling is that the solution to know the true or actual values of the various parameters of the population would be to take into account the entire population. This is not feasible due to the cost and time involved. Therefore, sampling seems more economical.
3. A sampling unit is a single member of the sample.
4. Sample saves time and cost. There are situations where a sample is the only option. If we want to estimate the average life of fluorescent bulbs, they are burnt out completely. In such cases, sampling scores over census.
5. A census is appropriate when the population size is small. For example, one wants to calculate the number of public sectors banks in the country.

6.5 SUMMARY

- A definite plan for obtaining a sample from the sampling frame is termed as sampling design. It refers to the technique or procedure, which a researcher adopts in selecting some sampling units from where inferences about population are drawn.
- Sampling is required for obtaining information because it saves time and money. It is less expensive and produces results at a faster speed.

NOTES

- Sampling involves determining a property or attribute to adhere to for the purpose of differentiating between items of a given population. The basic idea behind sampling is to use the common characteristics of average items as samples for a larger entity.
- Population refers to any group of people or objects that form the subject of study in a particular survey and are similar in one or more ways.
- An element comprises a single member of the population while a sample is a subset of the population. It comprises only some elements of the population.
- Sampling is a process of selecting an adequate number of elements from the population so that the study of the sample will not only help in understanding the characteristics of the population but will also enable us to generalize the results.
- Census is an examination of each and every element of the population is called census or complete enumeration.
- A census is appropriate when the population size is small, for example, the number of public sector banks in the country.

6.6 KEY WORDS

- **Quota Sampling:** It is a sample which includes a minimum number from each specified subgroup in the population.
- **Sampling Design:** It refers to a definite plan for obtaining a sample from the sampling frame.
- **Stratified Random Sampling:** It is a method of sampling that involves the division of a population into smaller groups known as strata. In stratified random sampling, or stratification, the strata are formed based on members' shared attributes or characteristics.
- **Sampling Frame:** It comprises all the elements of a population with proper identification that is available to us for selection at any stage of sampling.

6.7 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. Define sample design. Why do we need sample design?
2. State any one characteristic of sampling.
3. What is the census method?
4. What do you understand by sampling frame?

Long-Answer Questions

NOTES

1. Differentiate between census method and sampling method.
2. Discuss the need and advantages of sampling in detail.
3. Explain the advantages of sample over census.

6.8 FURTHER READINGS

Creswell, John W. 2002. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. London: Sage Publications Inc.

Booth, Wayne, Gregory G. Colomb and Joseph M. Williams. 1995. *The Craft of Research*. Chicago: University of Chicago Press.

Bryman, Alan and Emma Bell. 2015. *Business Research Methods.* 4th Edition. United Kingdom: Oxford University Press.

Gupta, S.L. and Hitesh Gupta. 2012. *Business Research Methods.* New Delhi: Tata McGraw Hill Education Private Limited.

UNIT 7 PROBABILITY AND NON-PROBABILITY SAMPLING METHODS, SAMPLE SIZE AND SAMPLING AND NON-SAMPLING ERRORS

Structure

7.0 Introduction
7.1 Objectives
7.2 Methods of Sampling: Probability, Non-Probility and Mixed Sampling Design (or Systematic Sampling)
7.3 Sample Size Determination, Calculation and Factors Affecting the Size of the Sample
7.4 Sampling and Non-Sampling Errors
  7.4.1 Biased Sample
7.5 Answers to Check Your Progress Questions
7.6 Summary
7.7 Key Words
7.8 Self Assessment Questions and Exercises
7.9 Further Readings

7.0 INTRODUCTION

In the previous unit, you were introduced to the concept of sampling design. A sample design is made up of two elements, that is, a sampling method and an estimator. In this unit, the discussion will turn towards how to determine sample size, the factors affecting the size of a sample as well as sampling and non-sampling errors.

7.1 OBJECTIVES

After going through this unit, you will be able to:

- Describe how to determine sample size
- Examine sampling and non-sampling errors
- Discuss biased sample
- Discuss the different methods of sampling

7.2 METHODS OF SAMPLING: PROBABILITY, NON-PROBABILITY AND MIXED SAMPLING DESIGN (OR SYSTEMATIC SAMPLING)

Sampling design refers to the process of selecting samples from a population. There are two types of sampling designs—probability sampling design and non-probability sampling design. Probability sampling designs are used in conclusive research. In a probability sampling design, each and every element of the population has a known chance of being selected in the sample. The known chance does not mean equal chance. Simple random sampling is a special case of probability sampling design where every element of the population has both known and equal chance of being selected in the sample. In case of non-probability sampling design, the elements of the population do not have any known chance of being selected in the sample. These sampling designs are used in exploratory research.

Probability Sampling Design

Under this, the following sampling designs would be covered—simple random sampling with replacement (SRSWR), simple random sampling without replacement (SRSWOR), systematic sampling, stratified random sampling and cluster sampling.

Simple random sampling with replacement

Under this scheme, a list of all the elements of the population from where the samples to be drawn is prepared. If there are 1000 elements in the population, we write the identification number or the name of all the 1000 elements on 1000 different slips. These are put in a box and shuffled properly. If there are 20 elements to be selected from the population, the simple random sampling procedure involves selecting a slip from the box and reading of the identification number. Once this is done, the chosen slip is put back to the box and again a slip is picked up and the identification number is read from that slip. This process continues till a sample of 20 is selected. Please note that the first element is chosen with a probability of 1/1000, the second one is also selected with the same probability and so are all the subsequent elements of the population.

An alternative way of selecting the samples from the population is by using random number tables. Table 7.1 gives an illustrative example of random numbers.

Table 7.1 *Select Four-digit Random Numbers*

I	II	III	IV	V
2807	0495	6183	7871	9559
8016	5732	3448	0164	2367
1322	4678	8034	1139	1474
0843	4625	7407	9987	5734
2364	1187	4565	2343	9786
4885	8755	4355	5465	0575
3406	4678	5950	7222	8494
5927	6010	7545	8979	1041
4447	3476	9140	0736	2332
4968	7553	1073	2493	4251
7489	1630	2330	4250	6170
4010	2707	3925	6007	8089
6531	9784	5520	7764	0008
7052	3861	7115	9521	2192
6573	2793	8710	2127	3846
8094	3205	2030	3035	5765
8615	6092	1900	4792	7684
9136	4016	3495	6549	9603
9656	5246	5090	8306	1522
2017	8323	1685	3006	3441

Table 7.1 gives four-digit random numbers arranged in 20 rows and five columns. These random numbers can be generated by a computer programmed to scramble numbers. The logic for generating random number is that any number can be constructed from numbers 0 to 9. The probability that any one digit from 0 through 9 will appear is the same as that for any other digit and the appearance of the numbers is statistically independent. Further, the probability of one sequence of digits occurring is the same as that for any other sequence of the same length.

The use of random number table for selecting samples could be illustrated through an example. Suppose there are 75 students in a class and it is decided to select 15 out of the 75 students. These students can be numbered from 01 to 75. Now, to pick up 15 students using random numbers and following the scheme of simple random sampling with replacement, we proceed as follows:

- With eyes closed, we place our finger on a number on the random number table. Suppose it is on the first row and the first column of our table. Now, we go down the first two columns and choose two-digit random numbers running from 01 to 75. If any number greater than 75 appears, it gets rejected. This way, the first number to be selected would be 28. The second number is 80, which would be rejected as we are choosing numbers from 01 to 75. The next selected number would be 13, followed by 08, 23, 48, 34, 59, 44, 49, 74, 40, 65, 70 and 65. Note that 65 has appeared twice. Since we are using the scheme of simple

random sampling with replacement, we would retain it. This way we have selected 14 samples. The 15th number selected would be 20. In brief, the scheme explained above states that any number greater than the population size (in this case 75) is rejected and only the numbers from 01 to 75 are selected. A number may get repeated because simple random sampling scheme is done with replacement.

Simple random sampling without replacement

In the case of simple random sample without replacement, the procedure is identical to what was explained in the case of simple random sampling with replacement. The only difference here is that the chosen slip is not placed back in the box. This way, the first unit would be selected with the probability of 1/1000, second unit with the probability of 1/999, the third will be selected with a probability of 1/998 and so on, till we select the required number of elements (in this case, 15) in our sample.

The simple random sampling (with or without replacement) is not used in a consumer research. This is because in a consumer research the population size is usually very large, which creates problems in the preparation of a sampling frame. For example, there is a large number of consumers of soft drinks, pizza, shampoo, soap, chocolate and so on. However, these (SRSWR and SRSWOR) designs could be useful when the population size is very small, for example, the number of steel/aluminium-producing companies in India and the number of banks in India. Since the population size is quite small, the preparation of a sampling frame does not create any problem.

Another problem with these (SRSWR and SRSWOR) designs is that we may not get a representative sample using such a scheme. Consider an example of a locality having 10,000 households, out of which 5,000 belong to low-income group, 3,500 belong to middle income group and the remaining 1,500 belong to high-income group. Suppose it is decided to take a sample of 100 households using the simple random sampling. The selected sample may not contain even a single household belonging to the high- and middle-income group and only the low-income households may get selected, thus, resulting in a non-representative sample.

Systematic sampling

Systematic sampling takes care of the limitation of the simple random sampling that the sample may not be a representative one. In this design, the entire population is arranged in a particular order. The order could be the calendar dates or the elements of a population arranged in an ascending or a descending order of the magnitude which may be assumed as random. List of subjects arranged in the alphabetical order could also be used and they are usually assumed to be random in order. Once this is done, the steps followed in the systematic sampling design are as follows:

- First of all, a sampling interval given by K = N/n is calculated, where N = the size of the population and n = the size of the sample. It is seen that the sampling interval K should be an integer. If it is not, it is rounded off to make it an integer.
- A random number is selected from 1 to K. Let us call it C.
- The first element to be selected from the ordered population would be C, the next element would be C + K and the subsequent one would be C + 2K and so on till a sample of size n is selected.

This way we can get representation from all the classes in the population and overcome the limitations of the simple random sampling. To take an example, assume that there are 1,000 grocery shops in a small town. These shops could be arranged in an ascending order of their sales, with the first shop having the smallest sales and the last shop having the highest sales. If it is decided to take a sample of 50 shops, then our sampling interval K will be equal to 1000 ÷ 50 = 20. Now we select a random number from 1 to 20. Suppose the chosen number is 10. This means that the shop number 10 will be selected first and then shop number

10 + 20 = 30 and the next one would be 10 + 2 × 20 = 50 and so on till all the 50 shops are selected. This way we can get a representative sample in the sense that it will contain small, medium and large shops.

It may be noted that in a systematic sampling the first unit of the sample is selected at random (probability sampling design) and having chosen this, we have no control over the subsequent units of sample (non-probability sampling). Because of this, this design at times is called mixed sampling.

The main advantage of systematic sampling design is its simplicity. When sampling from a list of population arranged in a particular order, one can easily choose a random start as described earlier. After having chosen a random start, every K^{th} item can be selected instead of going for a simple random selection. This design is statistically more efficient than a simple random sampling, provided the condition of ordering of the population is satisfied.

The use of systematic sampling is quite common as it is easy and cheap to select a systematic sample. In systematic sampling one does not have to jump back and forth all over the sampling frame wherever random number leads, and neither does one have to check for duplication of elements as compared to simple random sampling. Another advantage of a systematic sampling over simple random sampling is that one does not require a complete sampling frame to draw a systematic sample. The investigator may be instructed to interview every 10th customer entering a mall without a list of all customers.

There may be situations where it may not be possible to get a representative sample. The design can create problems if the sampling

interval is a whole number multiple of some cycle related to the problem. On this design there may be a problem that there is a high probability of systematic bias creeping into the sample resulting in a non-representative sample. Consider, for example, the case of a certain PVR cinema hall where there may be a couple of snack bars. We may be interested in estimating the average daily sales of a particular snack bar in that PVR. Now, using the daily data with the population and sample size known, we compute a sampling interval which may be a multiple of seven. Using this, we may select our first element which would reflect one of the seven days of the week, say Friday. The next element would also be Friday, as our sampling interval is a multiple of seven and so the subsequent elements of the population. Therefore, our sample would comprise only Fridays and the sample would not reflect day of the week variation in the sales data, which could result in a non-representative sample. Therefore, while using daily data, care should be taken that our sampling interval is not a multiple of seven.

Stratified random sampling

Under this sampling design, the entire population (universe) is divided into strata (groups), which are mutually exclusive and collectively exhaustive. By mutually exclusive, it is meant that if an element belongs to one stratum, it cannot belong to any other stratum. Strata are collectively exhaustive if all the elements of various strata put together completely cover all the elements of the population. The elements are selected using a simple random sampling independently from each group.

There are two reasons for using a stratified random sampling rather than simple random sampling. One is that the researchers are often interested in obtaining data about the component parts of a universe. For example, the researcher may be interested in knowing the average monthly sales of cell phones in 'large', 'medium' and 'small' stores. In such a case, separate sampling from within each stratum would be called for. The second reason for using a stratified random sampling is that it is more efficient as compared to a simple random sampling. This is because dividing the population into various strata increases the representativness of the sampling as the elements of each stratum are homogeneous to each other.

There are certain issues that may be of interest while setting up a stratified random sample. These are:

What criteria should be used for stratifying the universe (population)?

The criteria for stratification should be related to the objectives of the study. The entire population should be stratified in such a way that the elements are homogeneous within the strata, whereas there should be heterogeneity between strata. As an example, if the interest is to estimate the expenditure of households on entertainment, the appropriate criteria for stratification would be the household income. This is because the expenditure on entertainment and household income are highly correlated. As another example, if the

objective of the study is to estimate the amount of money spent on cosmetics, then, gender could be used as an appropriate criteria for stratification. This is because it is known that though both men and women use cosmetics, the expenditure by women is much more than that of their male counterparts. Someone may argue out that gender may no longer remain the appropriate criteria if it is not backed by income. Therefore, the researcher might have to use two or more criteria for stratification depending upon the problem in hand. This would only increase the number of strata thereby making the sampling difficult.

Generally stratification is done on the basis of demographic variables like age, income, education and gender. Customers are usually stratified on the basis of life stages and income levels to study their buying patterns. Companies may be stratified according to size, industry, profits for analysing the stock market reactions.

How many strata should be constructed?

Going by common sense, as many strata as possible should be used so that the elements of each stratum will be as homogeneous as possible. However, it may not be practical to increase the number of strata and, therefore, the number may have to be limited. Too many strata may complicate the survey and make preparation and tabulation difficult. Costs of adding more strata may be more than the benefit obtained. Further, the researcher may end up the practical difficulty of preparing a separate sampling frame as the simple random samples are to be drawn from each stratum.

What should be appropriate number of samples size to be taken in each stratum?

This question pertains to the number of observations to be taken out from each stratum. At the outset, one needs to determine the total sample size for the universe and then allocate it between each stratum. This may be explained as follows:

Let there be a population of size N. Let this population be divided into three strata based on a certain criterion. Let N_1, N_2 and N_3 denote the size of strata 1, 2 and 3 respectively, such that $N = N_1 + N_2 + N_3$. These strata are mutually exclusive and collectively exhaustive. Each of these three strata could be treated as three populations. Now, if a total sample of size n is to be taken from the population, the question arises that how much of the sample should be taken from strata 1, 2 and 3 respectively, so that the sum total of sample sizes from each strata adds up to n.

Let the size of the sample from first, second and third strata be n_1, n_2, and n_3 respectively such that $n = n_1 + n_2 + n_3$. Then, there are two schemes that may be used to determine the values of ni, (i = 1, 2, 3) from each strata. These are proportionate and disproportionate allocation schemes.

Proportionate allocation scheme: In this scheme, the size of the sample in each stratum is proportional to the size of the population of the

strata. As an example, if a bank wants to conduct a survey to understand the problems that its customers are facing, it may be appropriate to divide them into three strata based upon the size of their deposits with the bank. If we have 10,000 customers of a bank in such a way that 1,500 of them are big account holders (having deposits more than ₹ 10 lakh), 3,500 of them are medium sized account holders (having deposits of more than ₹ 2 lakh but less than ₹ 10 lakh), the remaining 5,000 are small account holders (having deposits of less than ₹ 2 lakh). Suppose the total budget for sampling is fixed at ₹ 20,000 and the cost of sampling a unit (customer) is ₹ 20. If a sample of 100 is to be chosen from all the three strata, the size of the sample from strata 1 would be:

$$n_1 = n \times \frac{N_1}{N} = 100 \times \frac{1500}{10000} = 15$$

The size of sample from strata 3 would be:

$$n_2 = n \times \frac{N_2}{N} = 100 \times \frac{3500}{10000} = 35$$

The size of sample from strata 3 would be:

$$n_3 = n \times \frac{N_3}{N} = 100 \times \frac{5000}{10000} = 50$$

This way the size of the sample chosen from each stratum is proportional to the size of the stratum. Once we have determined the sample size from each stratum, one may use the simple random sampling or the systematic sampling or any other sampling design to take out samples from each of the strata.

Disproportionate allocation: As per the proportionate allocation explained above, the sizes of the samples from strata 1, 2 and 3 are 15, 35 and 50 respectively. As it is known that the cost of sampling of a unit is ₹ 20 irrespective of the strata from where the sample is drawn, the bank would naturally be more interested in drawing a large sample from stratum 1, which has the big customers, as it gets most of its business from strata 1. In other words, the bank may follow a disproportionate allocation of sample as the importance of each stratum is not the same from the point of view of the bank. The bank may like to take a sample of 45 from strata 1 and 40 and 15 from strata 2 and 3 respectively. Also, a large sample may be desired from the strata having more variability.

Cluster sampling

In the cluster sampling, the entire population is divided into various clusters in such a way that the elements within the clusters are heterogeneous. However, there is homogeneity between the clusters. This design, therefore, is just the opposite of the stratified sampling design, where there was homogeneity within the strata and heterogeneity between the strata. To illustrate the example of a cluster sampling, one may assume that there is a company

having its corporate office in a multi-storey building. In the first floor, we may assume that there is a marketing department where the offices of the president (marketing), vice president (marketing) and so on to the level of management trainee (marketing) are there. Naturally, there would be a lot of variation (heterogeneity) in the amount of salaries they draw and hence a high amount of variation in the amount of money spent on entertainment. Similarly, if the finance department is housed on the second floor, we may find almost a similar pattern. Same could be assumed for third, fourth and other floors. Now, if each of the floors could be treated as a cluster, we find that there is homogeneity between the clusters but there is a lot of heterogeneity within the clusters. Now, a sample of, say, 2 to 3 clusters is chosen at random and once having done so, each of the cluster is enumerated completely to be able to make an estimate of the amount of money the entire population spends on entertainment.

Examples of cluster sampling could include ad-hoc organizational committees drawn from various departments to advise the CEO of a company on product development, new product ideas, evaluating alternative advertising programmes, budget allocations and marketing strategies. Each of the clusters comprises a heterogeneous collection of members with different interests, background, experience, value system and philosophy. The CEO of the company may be able to take strategic decisions based upon their combined advice.

Although the per unit costs of cluster sampling are much lower than those of other probability sampling, the applicability of cluster sampling to an organizational context may be questioned as a cluster may not contain heterogeneous elements. The condition of heterogeneity within the cluster and homogeneity between the clusters may not be met. As another example, the households in a block are to be similar rather than dissimilar and as a result, it may be difficult to form heterogeneous clusters.

Although the per unit costs of cluster sampling are much lower than those of other probability sampling, the applicability of cluster sampling to an organizational context may be questioned as a cluster may not contain heterogeneous elements. The condition of heterogeneity within the cluster and homogeneity between the clusters may not be met. As another example, the households in a block are to be similar rather than dissimilar and as a result, it may be difficult to form heterogeneous clusters.

Cluster sampling is useful when populations under a survey are widely dispersed and drawing a simple random sample may be impractical.

Non-probability Sampling Designs

Under the non-probability sampling, the following designs would be considered—convenience sampling, purposive sampling, snowball sampling and quota sampling.

Convenience sampling

Convenience sampling is used to obtain information quickly and inexpensively. The only criterion for selecting sampling units in this scheme is the convenience of the researcher or the investigator. Mostly, the convenience samples used are neighbours, friends, family members, colleagues and 'passers-by'. This sampling design is often used in the pre-test phase of a research study such as the pre-testing of a questionnaire. Some of the examples of convenience sampling are:

- People interviewed in a shopping centre for their political opinion for a TV programme.
- Monitoring the price level in a grocery shop with the objective of inferring the trends in inflation in the economy.
- Requesting people to volunteer to test products.
- Using students or employees of an organization for conducting an experiment.
- Interviews conducted by a TV channel of people coming out of a cinema hall, to seek their opinion about the movie.
- A researcher visiting a few shops near his residence to observe which brand of a particular product people are buying, so as to draw a rough estimate of the market share of the brand.

In all the above situations, the sampling unit may either be self-selected or selected because of ease of availability. No effort is made to choose a representative sample. Therefore, in this design the difference between the population value (parameters) of interest and the sample value (statistic) is unknown both in terms of the magnitude and direction. Therefore, it is not possible to make an estimate of the sampling error and researchers won't be able to make a conclusive statement about the results from such a sample. It is because of this, convenience sampling should not be used in conclusive research (descriptive and causal research).

Convenience sampling is commonly used in exploratory research. This is because the purpose of an exploratory research is to gain an insight into the problem and generate a set of hypotheses which could be tested with the help of a conclusive research. When very little is known about a subject, a small-scale convenience sampling can be of use in the exploratory work to help understand the range of variability of responses in a subject area.

Judgemental sampling

Under judgemental sampling, experts in a particular field choose what they believe to be the best sample for the study in question. The judgement sampling calls for special efforts to locate and gain access to the individuals who have the required information. Here, the judgement of an expert is used

to identify a representative sample. For example, the shoppers at a shopping centre may serve to represent the residents of a city or some of the cities may be selected to represent a country. Judgemental sampling design is used when the required information is possessed by a limited number/category of people. This approach may not empirically produce satisfactory results and, may, therefore, curtail generalizability of the findings due to the fact that we are using a sample of experts (respondents) that are usually conveniently available to us. Further, there is no objective way to evaluate the precision of the results. A company wanting to launch a new product may use judgemental sampling for selecting 'experts' who have prior knowledge or experience of similar products. A focus group of such experts may be conducted to get valuable insights. Opinion leaders who are knowledgeable are included in the organizational context. Enlightened opinions (views and knowledge) constitute a rich data source. A very special effort is needed to locate and have access to individuals who possess the required information.

The most common application of judgemental sampling is in business-to-business (B to B) marketing. Here, a very small sample of lead users, key accounts or technologically sophisticated firms or individuals is regularly used to test new product concepts, producing programmes, etc.

Snowball sampling

Snowball sampling is generally used when it is difficult to identify the members of the desired population, e.g., deep-sea divers, families with triplets, people using walking sticks, doctors specializing in a particular ailment, etc. Under this design each respondent, after being interviewed, is asked to identify one or more in the field. This could result in a very useful sample. The main problem is in making the initial contact. Once this is done, these cases identify more members of the population, who then identify further members and so on. It may be difficult to get a representative sample. One plausible reason for this could be that the initial respondents may identify other potential respondents who are similar to themselves. The next problem is to identify new cases.

Quota sampling

In quota sampling, the sample includes a minimum number from each specified subgroup in the population. The sample is selected on the basis of certain demographic characteristics such as age, gender, occupation, education, income, etc. The investigator is asked to choose a sample that conforms to these parameters. Field workers are assigned quotas of the sample to be selected satisfying these characteristics.

A researcher wants to measure the job satisfaction level among the employees of a large organization and believes that the job satisfaction level varies across different types of employees. The organization is having 10 per

cent, 15 per cent, 35 per cent and 40 per cent, class I, class II, class III and class IV, employees, respectively. If a sample of 200 employees is to be selected from the organization, then 20, 30, 70 and 80 employees from class I, class II, class III and class IV respectively should be selected from the population. Now, various investigators may be assigned quotas from each class in such a way that a sample of 200 employees is selected from various classes in the same proportion as mentioned in the population. For example, the first field worker may be assigned a quota of 10 employees from class I, 15 from class II, 20 from class III and 30 from class IV. Similarly, a second investigator may be assigned a different quota such that a total sample of 200 is selected in the same proportion as the population is distributed. Please note that the investigators may choose the employees from each class as conveniently available to them. Therefore, the sample may not be totally representative of the population, hence the findings of the research cannot be generalized. However, the reason for choosing this sampling design is the convenience it offers in terms of effort, cost and time.

In the example given above, it may be argued that job satisfaction is also influenced by education level, categorized as higher secondary or below, graduation, and postgraduation and above. By incorporating this variable, the distribution of population may look as given in Table 7.2. From the table, we may note that there are 8 per cent class I employees who are postgraduate and above, there are 35 per cent class IV employees with a higher secondary education and below and so on. Now, suppose a sample of size 200 is again proposed. In this case, the distribution of sample satisfying these two conditions in the same proportion in the population is given in Table 7.3.

Table 7.2 *Distribution of Population (percentage)*

Education	Category of Employees				
	Class I	Class II	Class III	Class IV	Total
Postgraduation and above	8	5	5	0	18
Graduation	2	10	20	5	37
Higher Secondary and below	0	0	10	35	45
Total	10	15	35	40	100

Table 7.3 *Distribution of Sample (numbers)*

Education	Category of Employees				
	Class I	Class II	Class III	Class IV	Total
Postgraduation and above	16	10	10	0	36
Graduation	4	20	40	10	74
Higher Secondary and below	0	0	20	70	90
Total	20	30	70	80	200

Table 7.3 indicates that a sample of 20 class II employees who are graduates should be selected. Likewise, a sample of 10 employees who possess postgraduate and above education should be selected. In the above

table, the sample to be taken from each of the 12 cells has been specified. Having done so, each of the investigators is assigned a quota to collect information from the employees conforming to the above norms so that a sample of 200 is selected.

Quota sampling design may look similar to the stratified random sampling design. However, there are differences between the two. In the stratified sampling design, the selection of sample from each stratum is random but in the quota sampling, the respondents may be chosen at the convenience or judgement of the researchers. Further, as already stated, the results of stratified random sampling could be generalized, whereas it may not be possible in the case of quota sampling. Quota sampling has some advantages over the probabilistic techniques. This design is very economical and it does not take too much time to set it up. Also, the use of this design does not require a sampling frame.

However, quota sampling also has certain weaknesses like:

- The total number of cells depends upon the number of control characteristics associated with the objectives of the study. If the control characteristics are large, the total number of cells increases, which may result in making the task of the investigator difficult.
- The chosen control characteristics should be related to the objectives of the study. The findings of the study could be misleading if any relevant parameter is omitted for one reason or the other.
- The investigator may visit those places where the chances of getting the respondents with the required control characteristics are high. The investigator could also avoid some responses that appear to be unfriendly. All this could result in making the findings of the study less reliable.

7.3 SAMPLE SIZE DETERMINATION, CALCULATION AND FACTORS AFFECTING THE SIZE OF THE SAMPLE

The size of a sample depends upon the basic characteristics of the population, the type of information required from the survey and the cost involved. Therefore, a sample may vary in size for several reasons. The size of the population does not influence the size of the sample.

There are various methods of determining the sample size in practice:

- Researchers may arbitrary decide the size of sample without giving any explicit consideration to the accuracy of the sample results or the cost of sampling. This arbitrary approach should be avoided.
- For some of the projects, the total budget for the field survey (usually mentioned) in a project proposal is allocated. If the cost of sampling

per sample unit is known, one can easily obtain the sample size by dividing the total budget allocation by the cost of sampling per unit. This method concentrates only on the cost aspect of sampling, rather than the value of information obtained from such a sample.

- There are other researchers who decide on the sample size based on what was done by the other researchers in similar studies. Again, this approach cannot be a substitute for the formal scientific approach.
- The most commonly used approach for determining the size of sample is the confidence interval approach covered under inferential statistics. Below will be discussed this approach while determining the size of a sample for estimating population mean and population proportion. In a confidence interval approach, the following points are taken into account for determining the sample size in estimation of problems involving means:
  (a) *The variability of the population:* It would be seen that the higher the variability as measured by the population standard deviation, larger will be the size of the sample. If the standard deviation of the population is unknown, a researcher may use the estimates of the standard deviation from previous studies. Alternatively, the estimates of the population standard deviation can be computed from the sample data.
  (b) *The confidence attached to the estimate:* It is a matter of judgement, how much confidence you want to attach to your estimate. Assuming a normal distribution, the higher the confidence the researcher wants for the estimate, larger will be sample size. This is because the value of the standard normal ordinate 'Z' will vary accordingly. For a 90 per cent confidence, the value of 'Z' would be 1.645 and for a 95 per cent confidence, the corresponding 'Z' value would be 1.96 and so on (see Appendix 1 at the end of the book). It would be seen later that a higher confidence would lead to a larger 'Z' value.
  (c) *The allowable error or margin of error:* How accurate do we want our estimate to be is again a matter of judgement of the researcher. It will of course depend upon the objectives of the study and the consequence resulting from the higher inaccuracy. If the researcher seeks greater precision, the resulting sample size would be large.

Sample size for estimating population mean

We have learnt in the central limit theorem that the sampling distribution of the sample mean follows a normal distribution with a mean $\mp$ and a standard error irrespective of the shape of population distribution whenever the sample size is large. Symbolically, it may be written as:

$$X \cap N(\mu, \tfrac{\sigma}{x})$$

$$n \times 30$$

The above also holds true whenever samples are drawn from normal population. However, in that case, the requirement of a large sample is not there. The various notations are explained as under:

$\bar{X}$ = Sample mean

μ = Population mean

$\frac{\sigma}{X}$ = Standard error of mean

n = Sample size

N = Population size

σ = Population standard deviation

The value of:

$$\frac{\sigma}{X} = \sigma / \sqrt{n} \text{ (when samples are drawn from an infinite population)}$$

$$= \frac{\sigma}{\sqrt{n}}\sqrt{\frac{N-n}{N-1}} \text{ (when samples are drawn from a finite population)}$$

The expression $\sqrt{\frac{N-n}{N-1}}$ is called the finite population multiplier and need not be used while sampling from a finite population provided $\frac{n}{N} < 0.05$.

The standard normal variate Z may be written as:

$$Z = \frac{\bar{X}-\mu}{\frac{\sigma}{x}}$$

$$Z = \frac{\bar{X}-\mu}{\frac{\sigma}{\sqrt{n}}}$$

$$Z = \frac{\bar{X}-\mu}{\sigma}\sqrt{n}$$

$$Z = \frac{e\sqrt{n}}{\sigma}$$

Where $\bar{x} - \mu = e$ = Margin of error

$$\therefore \qquad n = \frac{Z^2\sigma^2}{e^2}$$

It may be noted from above that the size of the sample is directly proportional to the variability in the population and the value of Z for a confidence interval. It varies inversely with the size of the error. It may also be noted that the size of a sample does not depend upon the size of population. Below are given some worked out examples for the determination of a sample size.

Example 7.1: An economist is interested in estimating the average monthly household expenditure on food items by the households of a town. Based on past data, it is estimated that the standard deviation of the population on the monthly expenditure on food item is ₹ 30. With allowable error set at ₹ 7, estimate the sample size required at a 90 per cent confidence.

Solution:

90 per cent confidence $\Rightarrow Z = 1.645$

$$e = ₹\ 7$$

$$\sigma = ₹\ 30$$

$$n = \frac{Z^2\sigma^2}{e^2}$$

$$= \frac{(1.645)^2(30)^2}{(7)^2}$$

$$= 49.7025$$

$$= 50 \text{ (approx.)}$$

Example 7.2: You are given a population with a standard deviation of 8.6. Determine the sample size needed to estimate the mean of the population within ± 0.5 with a 99 per cent confidence.

Solution:

99 per cent confidence $\Rightarrow Z = 2.575$

$$e = \pm 0.5$$

$$\sigma = 8.6$$

$$n = \frac{Z^2\sigma^2}{e^2}$$

$$= \frac{(2.575)^2(8.6)^2}{(0.5)^2}$$

$$= 1961.60$$

$$= 1962 \text{ (approx.)}$$

Example 7.3: It is desired to estimate the mean life time of a certain kind of vacuum cleaner. Given that the population standard deviation $\sigma = 320$ days, how large a sample is needed to be able to assert with a confidence level of 96 per cent that the mean of the sample will differ from the population mean by less than 45 days?

Solution:

96 per cent confidence $\Rightarrow Z = 2.055$

$$e = 45$$

$$\sigma = 320$$

$$n = \frac{Z^2\sigma^2}{e^2}$$

$$= \frac{(2.055)^2(320)^2}{(45)^2}$$

$$= 213.55$$

$$= 214 \text{ (approx.)}$$

Determination of sample size for estimating the population proportion

If the sample proportion $\overline{p}$ is used to estimate the population proportion p, the standard error of $\overline{p}\left(\frac{\sigma}{p}\right)$ would be $\sqrt{\frac{pq}{n}}$, where q = 1 – p. Now assuming normal distribution, we have

$$\overline{p} \cap N\left(p, \sqrt{\frac{pq}{n}}\right)$$

Therefore, $$Z = \frac{\overline{p} - p}{\sqrt{\frac{pq}{n}}}$$

Therefore, margin of error e = $\overline{p} - p = Z\sqrt{\frac{pq}{n}}$

$$Z = \frac{e}{\sqrt{\frac{pq}{n}}}$$

$$Z = \frac{e\sqrt{n}}{\sqrt{pq}}$$

$$n = \frac{Z^2 pq}{e^2}$$

The above formula will be used if the value of population proportion p is known. If, however, p is unknown, we substitute the maximum value of pq in the above formula. It can be shown that the maximum value of pq is ¼ when p = ½ and q = ½. This is shown in Figure 7.1.

Therefore, $$n = \frac{1}{4}\frac{Z^2}{e^2}$$

Let us consider a few examples for determining a sample size while estimating the population proportion.

Example 7.4: A market researcher for a consumer electronics company would like to study the television viewing habits of the residents of a particular, small city. What sample size is needed if he wishes to be 95 per cent confident of being within ± 0.035 of the true proportion who watch the evening news on at least three weeknights if no previous estimate is available?

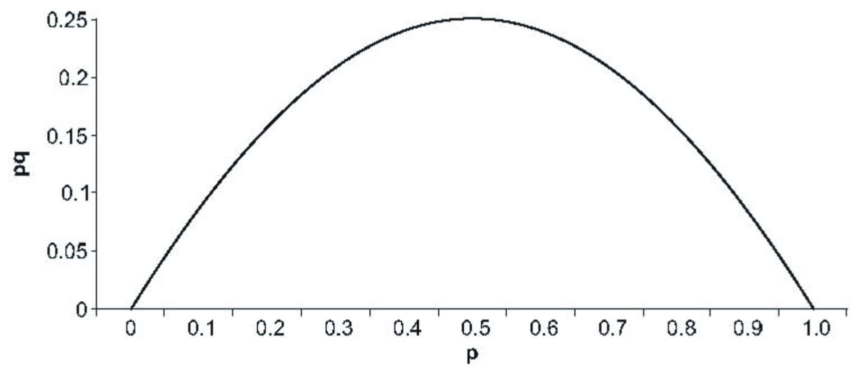


Fig. 7.1 Graph of pq Corresponding to the Values of p

Solution:

90 per cent confidence $\Rightarrow Z = 1.96$

$$e = \pm 0.035$$

$$n = n = \frac{1}{4}\frac{Z^2}{e^2}$$

$$= \frac{1}{4}\frac{(1.96)^2}{(0.035)^2}$$

$$= 784$$

Example 7.5: A manager of a department store would like to study women's spending per year on cosmetics. He is interested in knowing the population proportion of women who purchase their cosmetics primarily from his store. If he wants to have a 90 per cent confidence of estimating the true proportion to be within ± 0.045, what sample size is needed?

90 per cent confidence $\Rightarrow Z = 1.645$

$$e = \pm 0.045$$

$$n = n = \frac{1}{4}\frac{Z^2}{e^2}$$

$$= \frac{1}{4}\frac{(1.645)^2}{(0.045)^2}$$

$$= 334.0722$$

$$= 335 \text{ (approx.)}$$

Example 7.6: A consumer electronics company wants to determine the job satisfaction levels of its employees. For this, they ask a simple question, 'Are you satisfied with your job?' It was estimated that no more than 30 per cent of the employees would answer yes. What should be the sample size for this company to estimate the population proportion to ensure a 95 per cent confidence in result, and to be within 0.04 of the true population proportion?

Solution:

95 per cent confidence ⇒ Z = 1.96

$$e = 0.04$$

$$p = 0.3$$

$$q = 0.7$$

$$n = \frac{Z^2pq}{e^2}$$

$$= \frac{(1.96)^2 \times 0.3 \times 0.7}{(0.04)^2}$$

$$= 504.21$$

= 505 (approx.)

Factors to be noted for sample size determination

There are certain issues to be kept in mind before applying the formulas for the determination of sample size in this unit. First of all, these formulas are applicable for simple random sampling only. Further, they relate to the sample size needed for the estimation of a particular characteristic of interest. In a survey, a researcher needs to estimate several characteristics of interests and each one of them may require a different sample size. In case the universe is divided into different strata, the accuracy required for determining the sample size for each strata may be different. However, the present method will not able to serve the requirement. Lastly, the formulas for sample size must be based upon adequate information about the universe.

7.4 SAMPLING AND NON-SAMPLING ERRORS

There are two types of error that may occur while we are trying to estimate the population parameters from the sample. These are called sampling and non-sampling errors.

I. Sampling Error

This error arises when a sample is not representative of the population. For example, if our population comprises 200 MBA students in a business school and we want to estimate the average height of these 200 students by taking a sample of 10 (say). Let us assume for the sake of simplicity that the true value of population mean (parameter) is known. When we estimate the average height of the sampled students, we may find that the sample mean is far away from the population mean. The difference between the sample mean and the population mean is called sampling error, and this could arise because the sample of 10 students may not be representative of the entire population. Suppose now we increase the sample size from 10 to 15, we may find that

the sampling error reduces. This way, if we keep doing so, we may note that the sampling error reduces with the increase in sample size as an increased sample may result in increasing the representativeness of the sample.

Reducing the sampling errors

The following methods are useful in reducing sampling errors:

(i) **Increase in the size of the sample: As already mentioned,** the sampling error can be reduced by increasing the sample size. If the sample size equals the population size, then the sampling error is zero.

(ii) **Stratification:** A simple random sample is likely to be representative of the population if the population contains homogeneous units. However, when the population consists of dissimilar units, a simple random sample may not be representative of all types of units in the population. In order to improve the result of the sample, the sample design is modified. The population is divided into different groups comprising similar units. These groups are referred to as strata. From each group (stratum), a sub-sample is selected in a random manner. As a result, all the groups have representation in the sample, reducing the sampling error. It is known as stratified-random sampling.

II. Non-Sampling Error

This error arises not because a sample is not a representative of the population but because of other reasons. Some of these reasons are listed below:

- The respondents when asked for information on a particular variable may not give the correct answers. If a person aged 48 is asked a question about his age, he may indicate the age to be 36, which may result in an error and in estimating the true value of the variable of interest.
- The error can arise while transferring the data from the questionnaire to the spreadsheet on the computer.
- There can be errors at the time of coding, tabulation and computation.
- If the population of the study is not properly defined, it could lead to errors.
- The chosen respondent may not be available to answer the questions or may refuse to be part of the study.
- There may be a sampling frame error. Suppose the population comprises households with low income, high income and middle class category. The researcher might decide to ignore the low-income category respondents and may take the sample only from the middle and the high-income category people.

Reducing non-sampling errors

Non-sampling errors are a fraction of the total error arising from performing a statistical analysis. The balance of the total error arises from sampling

error. Unlike sampling error, increase in the sample size does not reduce non-sampling error. In fact, it is practically impossible to eliminate non-sampling errors entirely. However, we can reduce non-sampling errors in the following ways:

- **Improving survey processes:** Non-sampling errors can be reduced by improving survey processes. The survey should rely on the collection and analysis of data relating to editing performance as well as to the sources, types and distribution of errors in the data.
- **Systematic and orderly specification of edits**: For mitigation of non-sampling errors, there is a need for the systematic and orderly specification of edits and that the amendment of data should occur only in response to important errors. A balance should essentially be achieved between:
  - o Edits applied in the field and those applied in the office
  - o Automated and clerical approaches to verification and amendment of errors
  - o Use of micro and macro-editing methods
- **Use of computer-assisted telephone interviewing (CATI) and computer-assisted personal interview (CAPI) systems:** These systems allow for greater control than the normal paper questionnaire does. There is less leeway for interviewers to commit mistakes. Further, the integration of data collection, data entry and editing brings down the chances of errors in these systems. These systems have the technology to provide immediate feedback of possible errors. This helps the interviewer query during the interview.
- **Use of computer-assisted coding systems and automated coding systems:** These coding systems have the potential for more accurate and less expensive coding systems. Further, they result in more consistent coding.

7.4.1 Biased Sample

The purpose of research is to estimate an unbiased statistic that represents the true parameter for a population. Bias is defined as a predisposition to one particular outcome over another. Bias in research leads to unrepresentative outcomes. In other words, bias causes researchers' estimates to be predisposed to the left or to the right of the true mark.

Statistical estimates rely on random error, and bias introduces systematic error into the research design or analysis, rendering outcomes unreliable or meaningless. Random error is unpredictable, while systematic error is predictable. Obtaining a biased estimate can be the result of one or more mistakes made before, during, or after a study.

A sample that is not representative of the population from which it was drawn is called a biased sample.

Check Your Progress

1. What does a size of a sample depend upon?
2. Define sampling error.
3. What does bias in research lead to?
4. What is probability sampling design?
5. Define systematic sampling.
6. What is the importance of cluster sampling.

7.5 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. The size of a sample depends upon the basic characteristics of the population, the type of information required from the survey and the cost involved.
2. The difference between the sample mean and the population mean is called sampling error.
3. Bias in research leads to unrepresentative outcomes. In other words, bias causes researchers' estimates to be predisposed to the left or to the right of the true mark.
4. Under probability sampling design, simple random sampling will be replaced and sampling designs would be covered.
5. Systematic sampling takes care of the limitation of the simple random sampling that the sample may not be a representative one.
6. When populations under a survey are widely dispersed and drawing a simple random sample is required, cluster sampling comes to the rescue.

7.6 SUMMARY

- The size of a sample depends upon the basic characteristics of the population, the type of information required from the survey and the cost involved. Therefore, a sample may vary in size for several reasons.
- Researchers may arbitrary decide the size of sample without giving any explicit consideration to the accuracy of the sample results or the cost of sampling.
- In a survey, a researcher needs to estimate several characteristics of interests and each one of them may require a different sample size.

- There are two types of error that may occur while we are trying to estimate the population parameters from the sample. These are called sampling and non-sampling errors.
- A sampling error arises when a sample is not representative of the population.
- A non-sampling error arises not because a sample is not a representative of the population but because of other reasons.
- Non-sampling errors are a fraction of the total error arising from performing a statistical analysis. The balance of the total error arises from sampling error.
- Unlike sampling error, increase in the sample size does not reduce non-sampling error.
- The purpose of research is to estimate an unbiased statistic that represents the true parameter for a population.
- A sample that is not representative of the population from which it was drawn is called a biased sample.
- The process of selecting samples from a population is termed as sampling design. Two types of sampling designs are probability sampling design and non-probability sampling design.
- In the proportionate allocation scheme, the size of the sample in each stratum is proportional to the size of the population of the strata.
- In cluster sampling, the entire population is divided into various clusters in such a way that the elements within the clusters are heterogeneous.
- Convenience sampling is used to obtain information quickly and inexpensively. The only criterion for selecting sampling units in this scheme is the convenience of the researcher or the investigator.
- Snowball sampling is generally used when it is difficult to identify the members of the desired population, e.g., deep-sea divers, families with triplets, people using walking sticks, doctors specializing in a particular ailment, etc.
- In quota sampling, the sample includes a minimum number from each specified subgroup in the population. The sample is selected on the basis of certain demographic characteristics such as age, gender, occupation, education, income, etc.

7.7 KEY WORDS

- **Field Survey:** It is a type of field research by which archaeologists search for archaeological sites and collect information about the location, distribution and organization of past human cultures across a large area.

- **Non-Sampling Error:** It is a catch-all term for the deviations of estimates from their true values that are not a function of the sample chosen, including various systematic errors and random errors that are not due to sampling.
- **Bias:** It is disproportionate weight in favour of or against one thing, person, or group compared with another, usually in a way considered to be unfair.

7.8 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. What are the points that need to be taken into consideration while determining sample size?
2. How do we reduce non-sampling errors?
3. Write a short-note on biased sample.

Long-Answer Questions

1. Describe the methods for determining sample size.
2. What is sampling error? How can researchers reduce sampling errors?
3. Illustrate how to determine sample size for estimating population mean.
4. What are the methods of sampling? Discuss any two in detail.
5. Explain cluster sampling.
6. Analyse judgemental sampling.

7.9 FURTHER READINGS

Creswell, John W. 2002. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. London: Sage Publications Inc.

Booth, Wayne, Gregory G. Colomb and Joseph M. Williams. 1995. *The Craft of Research*. Chicago: University of Chicago Press.

Bryman, Alan and Emma Bell. 2015. *Business Research Methods.* 4th Edition. United Kingdom: Oxford University Press.

Gupta, S.L. and Hitesh Gupta. 2012. *Business Research Methods.* New Delhi: Tata McGraw Hill Education Private Limited.

UNIT 8 SOURCES AND COLLECTION OF DATA-I

NOTES

Structure

8.0 Introduction
8.1 Objectives
8.2 Sources of Data: Primary Data and Secondary Data
8.3 Modes of Data Collection
  8.3.1 Interview: Types, Conduct, Preparation, Effective Techniques and Limitation
  8.3.2 Observation: Types and Techniques
8.4 Answers to Check Your Progress Questions
8.5 Summary
8.6 Key Words
8.7 Self Assessment Questions and Exercises
8.8 Further Readings

8.0 INTRODUCTION

In this unit, you will be introduced to the process of data collection. Primary data can be obtained through observations or through direct communication with the persons associated with the selected subject by performing surveys or descriptive research. A telephonic interview is also usually limited to two persons. However, it is conducted over the telephone. Telephonic interviews are generally considered as the initial methods for screening the candidates for personal interviews. Observation methods can be categorized into different types depending on various factors such as style for recording the observed information, data needed for observation and activity of the observer. The information or the questions included in the schedule should be accurate and should enable the respondent to better understand the context in which the questions are asked.

8.1 OBJECTIVES

After going through this unit, you will be able to;

- Discuss the different sources of data
- Describe the types and methods of observation
- Explain the types and limitations of interview

8.2 SOURCES OF DATA: PRIMARY DATA AND SECONDARY DATA

NOTES

There are various methods of data collection which help the user to gather and compile information from various locations.

To understand the multitude of choices available to a researcher for collecting the project/study-specific information, one needs to be fully cognizant of the resources available for the study and the level of accuracy required. To appreciate the truth of this statement, one needs to examine the gamut of methods available to the researcher. The data sources could be either contextual and primary or historical and secondary in nature.

Primary data as the name suggests is original, problem- or project-specific and collected for the specific objectives and needs to be spelt out by the researcher. The authenticity and relevance is reasonably high. The monetary and resource implications of this are quite high and sometimes a researcher might not have the resources or the time or both to go ahead with this method. In this case, the researcher can look at alternative sources of data which are economical and authentic enough to take the study forward. These include the second category of data sources—namely the secondary data.

Secondary data as the name implies is that information which is not topical or research specific and has been collected and compiled by some other researcher or investigative body. The said information is recorded and published in a structured format, and thus, is quicker to access and manage. Secondly, in most instances, unless it is a data product, it is not too expensive to collect. As suggested in the opening vignette, the data to track consumer preferences is readily available and the information required is readily available as a data product or as the audit information which the researcher or the organization can procure.

8.3 MODES OF DATA COLLECTION

There are several methods of collecting primary data, which are as follows:

(a) Interview method
(b) Observation method
(c) Survey method
(d) Questionnaire method
(e) Schedule method
(f) Scaling technique

(g) Other methods are warranty cards, distributor audits, pantry audits, consumer panels, using mechanical devices, through projective techniques, depth interviews and content analysis.

8.3.1 Interview: Types, Conduct, Preparation, Effective Techniques and Limitation

Interview is the method of collecting data that involves a presentation of oral and verbal stimuli and the reply in terms of oral and verbal responses. Interview involves both personal interview as well as telephonic interview.

Personal Interviews

Personal interview involves two people: the interviewer and the interviewee. The interviewer is the person who questions the interviewee. There is a face-to-face discussion between them. There can be more than one interviewer while taking a personal interview. There are two types of interviews: direct personal interview and indirect oral interview.

In a direct personal interview, the interviewer collects information from the concerned sources. He should be present at the site from where the data has to be collected. This method is most appropriate for intensive investigations but this method may not be suitable in the situations where a direct contact with the concerned person is not possible. In such cases, an indirect oral examination or investigation takes place where the interviewer cross-examines the interviewee to check his knowledge about the problem under investigation. The information exchanged between the interviewee and the interviewer is recorded for future reference.

Personal interviews can be of the following types:

- **Structured Interviews:** If the personal interview takes place in a structured way, it is called a structured interview. In this type of personal interview, the set of questions to be asked are predefined and the techniques used to record the information are highly standardized. Structured interviews are economical, as they do not require much information from the interviewer. Structured interviews are used as a main technique to collect information in descriptive research studies.
- **Unstructured Interviews:** If the personal interview takes place in an unstructured way, it means, that the questions to be asked to the interviewee are decided at the time of interview. In this type of personal interview, the set of questions to be asked are not predetermined and there are no standardised techniques used. A list of additional questions is provided to the interviewer and it depends on him to ask these questions or not. This method demands deep knowledge and greater skills of the interviewer. You can use

unstructured interview as a main technique to collect information in the explorative and formulative research studies.

Telephonic Interview

NOTES

A telephonic interview is also usually limited to two persons; however, it is conducted over the telephone. Telephonic interviews are generally considered as the initial methods for screening the candidates for the personal interviews. This involves testing the various skills of the interviewee that include verbal reasoning and oral communication skills. Some of the important tips for the interviewee in a telephonic interview are:

- Must keep the resume in front of him/her.
- Should keep the employer research materials within easy reach.
- Should keep a note pad to highlight the important rationale of the interview.
- Should talk in a calm and cool manner.
- Should sound professional when answering the questions.

Limitations of interview method

- This method is time consuming.
- It is difficult to generalize the findings due to small sample size used in this method.
- The interviewer may be biased. This would make him ask close-ended questions, which affects the validity and reliability of interview.

Given below is an interview guide created for a beverage purchase and consumption study.

Interview guide: beverage purchase and consumption
Introduction and Warm Up

Hi, I am conducting a short survey on soft drink consumption. Thus, I would just take some insights from you on your purchase. There are no right or wrong answers, however, since you consume soft drinks, your opinion is really important for understanding the purchase behaviour.

1. Tell me something about yourselves… what do you do—as in occupation… your hobbies…your interests? How would you describe yourself as a person? Do you generally plan and buy….
2. **PROBE FURTHER – PSYCHOGRAPHICS/LIFESTYLE**
3. **PURCHase behaviour :**
4. This soft drink that you have purchased….how do you generally consume it…. Chilled/cool, can/bottle, stand alone or mixed with something.
5. If I were to ask you to list occasions for soft drinks' purchase, they would be:

   ____

   ____

   ____

NOTES

6. So when you are making this purchase, what triggers it:
   - brand
   - price
   - deals
   - taste
   - packaging
   - any other ____________

   PROBE ALL ATTRIBUTES FOR REASONS. *For example, what kind of deals? Packaging? brand image?*
7. Supposing your favourite brand is not available for purchase…..what do you do…….(PROBE)……do you move on to another store or pick up another brand……(PROBE) …….reason(s)
8. Supposing a company changes its packaging so that it is really eye catching, what is your reaction to it……(PROBE)……reason(s)
9. **EXPOSE PICTURE**

   I am going to show you some display pictures. Please tell me which one do you think looks attractive….. (let the respondent select)…….(PROBE reasons for liking)……would this move customers to go and look around and purchase……. (reason)……..would it influence you to buy…..(reasons)
10. **EXPOSE PICTURE**

    I am going to show you a picture of a store. Where would you generally expect the soft drinks to be placed…..in your opinion, is this the right place or can it be put somewhere else…..REASON
11. Buy one get one free, a freebie, coupons, prizes. Do you get moved to try out and buy some of these?.......which ones did you try……REACTION
12. Soft drinks companies come up with a lot of ads…. can you tell me something about some ads? What do you recall…….. (**note-** degree of recall and if brand recalled was the right match)……..did it influence your purchase of the drink. PROBE

Thank you.

8.3.2 Observation: Types and Techniques

The observation method is the most common method to study behavioural sciences. Observation is not a scientific method but it becomes a scientific tool when it is used for formulating the purpose of research. In this method, the information collected by the researcher is totally based on his observation. For example, if the researcher is studying about different brands of shoes, he will not ask the person wearing shoes of a particular brand. Rather he will observe it by himself and come to some conclusion. The main advantage of this method is that there are no chances of partiality if the observation is done accurately. Secondly, the information or the data collected through observation is related to what is currently happening, it is not affected by the past behaviour or future intentions. Thirdly, this method is independent of a person's willingness to respond and does not require much cooperation on the part of the person, as it happens to be the case in interview or questionnaire method. Observation

method is suitable in those situations where the respondent is not capable of expressing the feelings verbally.

Types of observation method

NOTES

Observation methods can be categorized into different types depending on various factors such as style for recording the observed information, data needed for observation and activity of the observer. Following are the different types of observation methods:

- **Structured observation:** It is an observation method in which the following points need to be considered:
  - o Careful definition of the matter that needs to be observed.
  - o Identification of the style that must be used to record the observed information.
  - o Standardization of the condition of observation.
  - o Selection of the data required for observation.

  This method is most appropriate where a descriptive study of the matter under observation is required.
- **Unstructured observation:** It is an observation method in which a careful definition of the matter to be observed, the style to be recorded, standardized condition of observation and the selection of the required data of observation are not properly known. This method is most appropriate where an explored study of the matter under observation is required.
- **Participant observation:** It is an observation method in which the observer is also a member of the group he is observing in order to understand the needs and the problems faced by the group in a better way. For example, a team leader who observes all his team members and also does the same work as his team members. There are several advantages of participant observation, which are:
  - o The researcher is able to record the natural behaviour of the group.
  - o The researcher can even gather information, which could not otherwise easily be obtained if he observes from an isolated situation.
  - o The researcher can even verify the truth of statements made by informants in the context of the questionnaires or a schedule.
- **Non-participant observation:** It is an observation method in which the observer is not a member of the group under observation. This method has a disadvantage that the observer is unable to sense what the other team members feel.

- **Disguised observation:** It is an observation method in which the members of the group are unaware of the fact that they are being observed.
- **Controlled observation:** The observation that takes place according to definite pre-arranged plans, involving experimental procedures is called controlled observation.
- **Uncontrolled observation:** The observation that takes place in the natural setting is called the uncontrolled observation. The main aim of this observation is to have spontaneous picture of the situation and for this the prime requirement is sufficient time.

Limitations of observation method

Though observation methods provide different ways for studying the behavioural science, there are some limitations while using these methods. Following are the limitations of observation methods:

- All observation methods are generally expensive.
- It provides very limited information regarding the observed matter.
- It may be affected by some unwanted factors. For example, people who are not involved in the direct observation might create a problem while collecting data through observation methods.

Points to be considered while doing observation

In the observation methods, researchers must keep in mind the following points at the time of observing any information:

- What should be observed?
- How the observation should be recorded?
- How the accuracy of the observation can be ensured?

An example of observation sheet is given below:

Observation Sheet: Organic Retailer

Name of Store:	Location:	Size of Store:
Store personnel (number):		
Store personnel (attitude):		
Store atmosphere:		
Approximate footfalls		
Weekdays:		weekends
Percentage of conversions		
Weekdays:		weekends

NOTES

Please mark (•) the items in stock

Product	**Stock**	**Product**	**Stock**
Tea		CEREALS	
Organic Tea		Amaranth	
Flavoured		Amaranth Popped	
Snacks		Amaranth Breakfast Cereal	
Cookies (Ragi/Ramdana)		Jhangara	
Bread		Ragi	
Namkins		Ragi Atta	
Spices		Maize	
Chilli Powder		Maize Atta	
Chilli Red		Wheat Atta	
Dhania Powder		Wheat Dalia	
Dhania Seeds		Wheat Puffed	
Haldi Whole		PULSES	
Haldi Powder		Arhar Dal	
Mustard Powder		Bhatt Dal	
Sesame/Til		Kulath Dal	
Zeera		Masoor Dal	
PRESERVES		Moong Sabut	
Mango Pickle		Moong Dal	
Garlic Pickle		Kabuli Channa	
Mixed Pickle		Naurangi Dal	
Amla Chutney		Rajma (Brown/White)	
Ginger Ale		Rajma (Chitkabra)	
Burans Squash		Rajma (Mix)	
Lemon Squash		Rajma (Red Small)	
Malta Squash		Urad Dal	
Pudina Squash		Urad Whole	
		RICE	
ANY OTHER		Basmati Dehradun	
		Rice Khanda	
		Rice Rikhwa	
		Rice Unpolished	
		Rice Hansraj	

NOTES

		Rice Red	
		Rice Kasturi	
		Rice Kelas	
		Rice Punjab Basmati	
		Rice Ramjavan	
		Rice Sela	

Check Your Progress

1. What is primary data?
2. What is non-participant observation?
3. What is uncontrolled observation?

8.4 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. Primary data as the name suggests is original, problem- or project-specific and collected for the specific objectives and needs to be spelt out by the researcher.
2. It is an observation method in which the observer is not a member of the group under observation.
3. The observation that takes place in the natural setting is called the uncontrolled observation.

8.5 SUMMARY

- There are various methods of data collection which help the user to gather and compile information from various locations.
- Primary data as the name suggests is original, problem- or project-specific and collected for the specific objectives and needs to be spelt out by the researcher.
- There are several methods of collecting primary data, which are as follows:
  - (a) Interview method
  - (b) Observation method
  - (c) Survey method
  - (d) Questionnaire method
  - (e) Schedule method

(f) Scaling technique

(g) Other methods are warranty cards, distributor audits, pantry audits, consumer panels, using mechanical devices, through projective techniques, depth interviews and content analysis.

- Interview is the method of collecting data that involves a presentation of oral and verbal stimuli and the reply in terms of oral and verbal responses. Interview involves both personal interview as well as telephonic interview.
- Personal interview involves two people: the interviewer and the interviewee. The interviewer is the person who questions the interviewee.
- The observation method is the most common method to study behavioural sciences. Observation is not a scientific method but it becomes a scientific tool when it is used for formulating the purpose of research.
- Observation methods can be categorized into different types depending on various factors such as style for recording the observed information, data needed for observation and activity of the observer.

8.6 KEY WORDS

- **Secondary Data:** It refers to data which is collected by someone who is someone other than the user.
- **Interview:** It refers to a meeting of people face to face, especially for consultation.
- **Observation:** It means the action or process of closely observing or monitoring something or someone.

8.7 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. What are the various methods of data collection?
2. What are unstructured interview?

Long-Answer Questions

1. What is personal interview? Discuss the various types of personal interview.
2. Examine the types and techniques of the observation method.

8.8 FURTHER READINGS

NOTES

Creswell, John W. 2002. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. London: Sage Publications Inc.

Booth, Wayne, Gregory G. Colomb and Joseph M. Williams. 1995. *The Craft of Research*. Chicago: University of Chicago Press.

Bryman, Alan and Emma Bell. 2015. *Business Research Methods.* 4th Edition. United Kingdom: Oxford University Press.

Gupta, S.L. and Hitesh Gupta. 2012. *Business Research Methods.* New Delhi: Tata McGraw Hill Education Private Limited.

BLOCK - III

TOOLS OF DATA COLLECTION

NOTES

UNIT 9 SOURCES AND COLLECTION OF DATA-II

Structure

9.0 Introduction
9.1 Objectives
9.2 Schedule: Meaning, Kinds, Essentials, Procedure for the Formulation of a Schedule
  9.2.1 Schedules Vs. Questionnaires
9.3 Questionnaire: Meaning, Types and Format of a Good Questionnaire
9.4 Answers to Check Your Progress Questions
9.5 Summary
9.6 Key Words
9.7 Self Assessment Questions and Exercises
9.8 Further Readings

9.0 INTRODUCTION

In the previous unit, you were introduced to the process of data collection. In this unit, the discussion on the collection of data will continue. As you learnt, there are essentially two sources of data, that is, primary and secondary data. Two of the important methods of collecting primary data are interviews and schedule. We will discuss these in detail in this unit.

9.1 OBJECTIVES

After going through this unit, you will be able to:

- Discuss the meaning and types of questionnaire
- Explain the types and characteristics of a schedule
- Differentiate between questionnaire and schedule

9.2 SCHEDULE: MEANING, KINDS, ESSENTIALS, PROCEDURE FOR THE FORMULATION OF A SCHEDULE

A schedule is a questionnaire containing a set of questions that are required to be answered to collect the data about a particular item. A schedule generally takes place in a face-to-face manner.

Objectives of a schedule

The following are the main objectives of a schedule:

- A schedule is created for a definite item of enquiry. The schedule sets the boundaries for the subject under study.
- A schedule acts as an aid to memorise the information being collected by the interviewer. Since the interviewer collects the information from various respondents, he might get confused while analysing and tabulating the data.
- A schedule helps in tabulating and analysing the data in a systematic and standardised manner.

Types of schedules

There are five types of schedules, which are as follows:

1. **Observation schedule:** It is the schedule under which the observer observes all the activities and records all the responses of the respondents under some predefined conditions. The chief idea behind examining the activities is to verify the required information.
2. **Rating schedule:** It is the schedule used to measure and rate the thoughts, preferences, self-consciousness, perceptions and other similar characteristics of the respondents.
3. **Document schedule:** It is the schedule used for collecting the important data and preparing a source list. This schedule is mostly used to attain data from autobiographies, diaries or records of governments regarding written facts and case histories.
4. **Institution survey schedule:** It is the schedule used for studying different problems of institutions.
5. **Interview schedule:** It is the schedule under which an interviewer asks the questions to the interviewee and records his response in the given space of the questionnaire.

Merits of the schedule method

Following are the merits of the schedule method:

- In this method, the researcher is always there to help the respondents. So, the response rate is high as compared to other methods of data collection.
- The presence of researcher not only removes the doubts present in the minds of the respondents but also avoid fake replies from the respondents due to the fear of cross checking.

- In this method, there is a personal contact between the researcher and the respondent. Thus, the data can be collected easily and can be relied upon.
- This method helps to better understand the personality, living conditions and the values of the respondents.
- It is easy for the researcher to detect and rectify the defects in the schedule during sampling.

Limitations of schedule method

Following are the limitations of the schedule method:

- It is a costly and time-consuming method.
- This method requires well-trained and experienced field workers to take the interview of the respondents.
- Sometimes, the respondent may not be able to tell certain facts due to the personal presence of some researchers at the work.
- If the field of research is dispersed, it becomes difficult to organise the various activities of the research.

Characteristics of a good schedule

The essential characteristics of a good schedule are as follows:

- The information or the questions included in the schedule should be accurate and should enable the respondent to better understand the context in which the questions are asked.
- The schedule should be pre-arranged and structured in such a manner that the information gathered or collected is accurate and tenable. For this, the following points must be considered:
  - o The size of the schedule should be accurate.
  - o The questions in the schedule should be understandable and should be definite.
  - o The questions should not contain any biased evaluation.
  - o All the questions of the schedule should be properly interlinked.
  - o Information gathered should be organised in a table so that it can be easily used for statistical analysis.

Suitability of schedule method

The schedule method is mostly applied in the following situations:

- When the field of investigation is wide and dispersed.
- When the researcher requires quick results at lower cost.
- When the respondents are well trained and educated.

Organisation of schedule

Following is the sequence in which a schedule must be organised:

- **Selection of respondents:** Usually sampling method is used for the selection of respondents. The sample should be representative of the respondents and should contain all the relevant information about the respondents.
- **Selection and training of field workers:** Since the field workers take the interview of the respondents and collect the required data, the selection of the field workers should be done carefully and proper training should be provided to them.
- **Conducting interviews:** For a successful interview and correct result, the following points must be considered:
  - o **Follow correct approach:** The field worker should approach the respondents in a correct manner so that the respondents can clearly understand the purpose of the interview.
  - o **Generating accurate responses:** For proper and accurate response from the respondents, the respondents should not be misunderstood in their perspective and context.

Testing the validity of the gathered data

After the respondents fill in the schedule, the gathered data is subjected to certain tests in order to find out their correctness. For this, the researcher can again conduct the interview of the respondents and check for any variation. If the variations are enormous, then the gathered data is not accurate and the schedule is either rejected or modified.

9.2.1 Schedules Vs. Questionnaires

When you work with questionnaires and schedules, there are several similarities between the two. However, there are prominent differences, which differentiates the two:

- The questionnaire is mostly sent by the interviewer to the interviewee by mail and is filled by the interviewee whereas, a schedule is filled by the interviewer at the time of interview.
- Data collection through questionnaire is cheaper when compared to schedules as money is spent only in preparing schedules and mailing it. In schedule method, extra money is spent on appointing the interviewers and imparting training to them.
- In case of a questionnaire, the response is generally low because most people do not respond to the questions. On the other hand, response is high in the case of schedules since the interviewer fills them at the time of interview.

NOTES

- Identity of the respondent is not always clear in case of questionnaire, whereas, in case of schedules the identity of the interviewee or respondent is known.
- The questionnaire method is time consuming as the respondent may not return the questionnaire in time. There is no such problem in the scheduled method as the interviewer fills the schedules at the time of interview.
- A questionnaire does not allow personal contact with the respondent. Schedules establish direct contact with the interviewer.
- Questionnaire method is useful only in case if the respondent is literate, while in case of schedule it is not necessary for the interviewee to be literate.
- Risk of incomplete and incorrect information is more in questionnaire, while in schedules, the information collected is complete and more accurate.

9.3 QUESTIONNAIRE: MEANING, TYPES AND FORMAT OF A GOOD QUESTIONNAIRE

The questionnaire form is an important and commonly used method of data collection. It is used mostly in case of large-scale enquiries. The categories of end users who use this technique include individuals, research workers, private and public organisations and governments. A questionnaire is a document that contains a set of questions printed or typed in a proper sequence. The questionnaire is sent to each individual who is supposed to answer it. This technique of collecting information through questionnaires is extensively used nowadays. The following are the advantages of a questionnaire:

- It is cost-effective.
- As the respondents are allowed to answer the questions according to their own views and understanding, this technique of data collection is non-partial.
- All the respondents of the questionnaire are provided enough time to answer the questions.
- In this technique, a large sample of questions can be used to make the results more reliable.

In addition to the advantages mentioned above, questionnaires also have certain disadvantages. The disadvantages are as follows:

- This technique has possibilities of no-response. It means that the respondents may or may not provide answers to all the questions asked.
- This technique can be used only if the respondents are skilled and supportive.

- There are possibilities of vague replies by some respondents.
- It is not possible to determine whether or not a particular candidate is appropriate to give information about a particular subject.
- It is a time consuming technique.

In a questionnaire, the use of standardized questions can help collect more data that is reliable. By using questionnaires, the system analyst can collect valuable information from the people in the organisation who may be affected by the current and proposed system.

The various tasks performed during the questionnaire method are as follows:

- Acquiring information before conducting the interview with the questionnaire.
- Gaining information in order to prove facts found in the interview.
- Acquiring information on 'How users feel about the current system?'
- Is there any problem that remains unsolved?
- What do people expect from a new or modified system?

The following are the situations during which the questionnaires should be used:

- If the people to be questioned belongs to different departments or branches of the same organisation.
- If the project involves a large number of people and you want to know what proportion of a given group approves or disapproves of a particular feature of the proposed system.
- If you want to determine the overall opinion before the systems project is given any consideration for implementation.

Questions included in a questionnaire can be either closed ended or open ended.

Open-ended questions

Open ended questions are questions which do not require specific responses. Examples of this type of questions are as follows:

- How will you evaluate the benefits of a new installed system?
- How will you design the Management Information System?
- What is your opinion about the current income tax policy?

Closed-ended questions

Closed ended questions are the questions, which are used when the systems analyst is able to effectively list all possible responses to the question. All possible responses of the closed questions should be mutually exclusive. This type of questions are categorized in to the following types:

NOTES

- Fill in the blanks questions
- Dichotomous questions
- Ranking scale questions
- Multiple choice questions
- Rating scale questions

Fill in the blanks questions

These are questions which require specific responses that are analysed statistically. The examples of this type of questions are:

- What is your name?
- What is the name of your organisation?
- How many employees are there in the accounts department of your organisation?
- How many automated systems are installed in your organisation?

Dichotomous questions

Dichotomous questions are questions which offer two answers, Yes or No. The examples of this type of questions are:

- Are you working with manual systems?

  Yes or No
- If yes, do you need to switch over to the automated systems?

  Yes or No
- If no, are you satisfied with the performance of manual systems?

  Yes or No

Ranking scale questions

Ranking scale questions allow the researcher to arrange the list of items in the order of their importance and preference. Consider the following question:

Please arrange the following in alphabetical order:

- London
- America
- India
- Italy

Multiple choice questions

These types of questions allow you to select an option from a list of options. The examples of this type of question are:

- What is the number of automated systems used in your organisation?
  - o 0–9
  - o 10–19
  - o 20–29
  - o More than 29
- What is the type of organisation you are working with?
  - o Bank
  - o Manufacturing Company
  - o Computer/IT Sector
  - o Other

Rating scale questions

In this type of questions, a user is required to rate the options according to his opinion. The examples of this type of question are as follows:

How skilled you are in your work? (Helps in rating your skills)

	Once	Twice	Many times	Never
• Number of times you got promotion.	1	2	3	4
• Number of times you received appreciation.	1	2	3	4
• Number of times you are criticized for work.	1	2	3	4

Designing a questionnaire

Questionnaire provides a data collection technique in which written questions are presented that are to answered by the people in written form. The points that should be kept in mind while designing a questionnaire are as follows:

- The goal of the questionnaire must specify the purpose of determining whom you will survey and what will you ask them.
- The questions in the questionnaire must not be confusing and unfamiliar. It should be easy to understand, short and simple so that it is easy to complete.
- The questions in the questionnaire must be properly stated. It should not contain any private questions regarding the salary, age, etc.
- The questions placed out of order or out of context should be avoided. There should be specific questions, which can be followed by general easy-to-answer questions.
- The period or time must be stated in which the questionnaire can be completed.
- The performance of the questionnaire should be determined by pretesting it.

- The questionnaire should be finally reviewed and edited to ensure that the questionnaire is ready for administration.
- The type of questionnaire should be properly defined.

NOTES

Reliable and valid questionnaires are designed using the scaling construction technique. According to this technique, the researcher must focus on the question content, question wording and question format. Please refer to appendices too.

A Specimen questionnaire

This hypothetical study is adapted from a study developed by Deepak Mehendru* in India. Assume that this study involves 200 professors in India area colleges who are asked about their interest in buying automobiles. The basic objective of this survey is to determine certain marketing trends among the population of professors in India area regarding their automobile buying patterns and are based upon the following factors:

- The profile of the decision-maker who finally decides to buy a particular type of car.
- People around the decision-maker who influence the decision-making process.
- The factors affecting the selection of a particular dealer of cars.
- People in the family who make or affect decisions regarding the maximum budget that can be allocated for purchasing a car.
- The effect of various options available in the car.
- The image and reliability of the company that makes these cars.
- The effect of heavy promotion on television about the utility of the car on the decision maker.

(For the sake of simplicity, it is assumed that the professors have only one car in the family.)

The questionnaire

1. General

   Name..

   Age...

   Sex.........*M*.........*F*..

   Marital Status .... Married .... Unmarried ....

   Number of members in the family

   1–2..................

   3–4..................

5–6..................

Over 6.............

Yearly income

Less than ₹30,000..................

₹30,000–₹39,999.....................

₹40,000–₹49,999.....................

₹50,000 and more..................

2. What type of car do you own now?

 ....American

 ....Japanese

 ....European

3. What size of car do you own?

 ....Luxury

 ....Mid-size

 ....Compact

4. Did you buy this car new or used?

 ....New...................Used

5. If you bought a used car, did you buy it from a dealer or a private party? ....Dealer................Private party

6. If you bought a new car, how long have you owned this car?

 ....Number of years

7. If you bought a used car, how old is this car now?

 ....Number of years

8. Price paid for the car..........New..........Used

9. Who influenced your decision to purchase the above brand of car? Indicate if more than one.

 ....Yourself ....Your wife

 ....Your children .... Your friend

 ....Your neighbour ....Your colleague

 Others.. .

10. Indicate as to who decided about the budget allocation for the car?

 ....Yourself

 ....Your spouse

 ....Family decision

NOTES

11. If you bought your car from a dealer, then who influenced your decision regarding the selection of a particular dealer?

 ....Yourself

 ....Your friend

 ....Your colleague

 ....Family decision

12. How did you come to know about this dealer?

 ....TV commercial

 ....Newspapers

 ....Personal references

 ....Others

13. Rank the following factors that affected the final decision at the time of purchasing the car (A rank of 1 measures the most important factor, a rank of 2 measures the second most important factor, and so on).

 ....Very inconvenient without the car

 ....Money was available

 ....Reputation of car manufacturer

 ....Discounts offered

 ....Interest rate on financing

 ....Guarantees and warranties offered

 ....Others

14. Did you make an extensive survey regarding price comparisons after you decided to buy the particular car? .... Yes......... No.

15. If you bought a used car, how did you learn about it?............ Newspapers

 ....Friend .... Others

16. In order of preference, what were the major reasons for buying a used car?

 ....Unavailability of adequate funds

 ....Cheaper insurance

 ....Lack of parking garage

 ....Condition of the car

 ....Others

17. Which of the following media you think is most effective in creating an impact on the potential customer relative to a particular brand of the car?

................TV	...............Newspapers
................Magazines	...............Favourable news reports
................Word of mouth	...............Others

NOTES

The responses to such questions would form the basis of analysis in order to achieve the set marketing objectives.

Questionnaire designing is an important part of research methodology thus, we have dealt with this topic in great detail in the appendix given at the end of the book.

Characteristics of a good questionnaire

- The questionnaire is a very important document that is the first interface between the respondent and the researcher. Thus, the appearance of the instrument is very important. The first thing is the quality of the paper on which the questionnaire is printed. In case the questionnaire is printed on a poor-quality paper or looks tattered and unprofessional, the respondents do not value the study and thus are not very sincere or careful in responding.
- In case the number of questions is too many, instead of just stapling the papers together, it would be a good idea to put them together as a booklet. They are easy for the investigator and the subject to answer. Secondly, one can have a double-page format for the questions and the appearance, then, is more sombre and professional. The format, spacing and positioning of the questions can have a significant effect on the results, especially in the case of self-administered questionnaires.
- The font style and spacing used in the entire document should be uniform. One must ensure that every question and its response options are printed on the same page. In fact, as far as possible, the response categories should be in the same row as the question. This saves space and at the same time, is more response friendly.
- In case the questionnaire is long, or the researcher is economizing, one must not crowd questions together with no line spacing to make the questionnaire seem shorter. This format could result in error while recording as the person could fill the answer in the wrong row. Secondly, in case there are open-ended questions as well, the responses would be less revealing and shorter. The respondent might feel that this is going to be a really long and complex administration and may actually lose interest. Thus, though it is advisable to have short instruments that are not too taxing, but in case here is a research need for which the questions cannot be shortened, one must not clutter the appearance of the measuring instrument (questionnaire).

NOTES

- Although the use of colour does not really impact the quality of the response, sometimes it can be used to distinguish between the groups or for branching questions. Also, surveys for different groups could be on different coloured paper. This would be helpful when grouping the responses from different segments. For example, if Delhi is being studied as five zones, then the questionnaire used in each zone could be printed on a differently coloured paper.
- As we saw in the last section, the questionnaire is segregated into different sections to address the various information needs. It is useful if the researcher divides the data needed into separate sections such as Sections A, B, C and so on.
- Then the questions in each part should be numbered, especially, when one is using branching questions. The other advantage of numbering the questions is that after the conduction coding, entering the data obtained becomes much easier. Precoded questionnaires are easier to administer and record.
- In case there is any response instruction for an individual question, it must accompany the question. In case it is a schedule and there are instructions for asking the question as well as instructions for responding, the response instruction should be placed very close to the question. However, instructions about how to record the answer and any probing question that needs to be asked should be placed after the question. To distinguish the instructions from questions, one should use a different font style. For example, overall how satisfied (are/were) you with your [Domino's] experience? Would you say you are (READ LIST)?

  Very satisfied 5

  Satisfied 4

  Neither satisfied nor dissatisfied 3

  Dissatisfied 2

  Or, Very dissatisfied 1

  IN CASE OF 2 or 1

  (PROBE) What was the reason (s) for your experience? Kindly explain.

Check Your Progress

1. When is a questionnaire form used?
2. What are open-ended questions?
3. What is an observation schedule?
4. What method is used for the selection of respondents?

NOTES

9.4 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. The questionnaire form is an important and commonly used method of data collection. It is used mostly in case of large-scale enquiries.
2. Open ended questions are questions which do not require specific responses.
3. An observation schedule is the schedule under which the observer observes all the activities and records all the responses of the respondents under some predefined conditions.
4. Usually sampling method is used for the selection of respondents.

9.5 SUMMARY

- The questionnaire form is an important and commonly used method of data collection. It is used mostly in case of large-scale enquiries.
- The questionnaire is sent to each individual who is supposed to answer it. This technique of collecting information through questionnaires is extensively used nowadays.
- In a questionnaire, the use of standardized questions can help collect more data that is reliable. By using questionnaires, the system analyst can collect valuable information from the people in the organisation who may be affected by the current and proposed system.
- Closed ended questions are the questions, which are used when the systems analyst is able to effectively list all possible responses to the question.
- Ranking scale questions allow the researcher to arrange the list of items in the order of their importance and preference.
- Questionnaire provides a data collection technique in which written questions are presented that are to answered by the people in written form.
- In case the questionnaire is long, or the researcher is economizing, one must not crowd questions together with no line spacing to make the questionnaire seem shorter.
- A schedule is a questionnaire containing a set of questions that are required to be answered to collect the data about a particular item.
- There are five types of schedules, which are as follows:
    1. Observation schedule

NOTES

2. Rating schedule
3. Document schedule
4. Institution survey schedule
5. Interview schedule

- The information or the questions included in the schedule should be accurate and should enable the respondent to better understand the context in which the questions are asked.
- After the respondents fill in the schedule, the gathered data is subjected to certain tests in order to find out their correctness.
- When you work with questionnaires and schedules, there are several similarities between the two. However, there are prominent differences, which differentiates the two.
- In case of a questionnaire, the response is generally low because most people do not respond to the questions. On the other hand, response is high in the case of schedules since the interviewer fills them at the time of interview.
- Risk of incomplete and incorrect information is more in questionnaire, while in schedules, the information collected is complete and more accurate.

9.6 KEY WORDS

- **Schedule:** It is a questionnaire containing a set of questions that are required to be answered to collect the data about a particular item.
- **Rating Schedule:** It is the schedule used to measure and rate the thoughts, preferences, self-consciousness, perceptions and other similar characteristics of the respondents.
- **Questionnaire:** It is a set of printed or written questions with a choice of answers, devised for the purposes of a survey or statistical study.
- **Institution Survey Schedule:** It is the schedule used for studying different problems of institutions.

9.7 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short Answer Questions

1. List the tasks performed during the questionnaire method.
2. What are dichotomous questions?

3. What are the objectives of a schedule?
4. Differentiate between questionnaires and schedules.

Long Answer Questions

1. What is a questionnaire? Discuss its advantages and disadvantages.
2. Discuss how to design questionnaires.
3. Describe the characteristics of schedules. What are the various types of schedules?
4. Discuss the merits and limitations of the scheduling method.

9.8 FURTHER READINGS

Creswell, John W. 2002. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. London: Sage Publications Inc.

Booth, Wayne, Gregory G. Colomb and Joseph M. Williams. 1995. *The Craft of Research*. Chicago: University of Chicago Press.

Bryman, Alan and Emma Bell. 2015. *Business Research Methods.* 4th Edition. United Kingdom: Oxford University Press.

Gupta, S.L. and Hitesh Gupta. 2012. *Business Research Methods.* New Delhi: Tata McGraw Hill Education Private Limited.

NOTES

UNIT 10 SOURCES AND COLLECTION OF DATA-III

Structure

10.0 Introduction
10.1 Objectives
10.2 Scaling Techniques: Meaning, Importance, and Classification
  10.2.1 Types of Measurement Scales: Nominal, Ordinal, Interval and Ratio
10.3 Methods of Construction of Questionnaires or Schedules
10.4 Pre-Testing of Data Collection Tools
10.5 Validity and Reliability Methods
10.6 Answers to Check Your Progress Questions
10.7 Summary
10.8 Key Words
10.9 Self Assessment Questions and Exercises
10.10 Further Readings

10.0 INTRODUCTION

In the previous units, you have been introduced to concepts related to collection of data. You have learnt that sources are primary and secondary in nature. You have also learned about the questionnaire' and scheduling method of collecting data. In this unit, we will discuss scaling techniques of collecting data. Scaling basically is the process of generating the continuum, a continuous sequence of values, upon which the measured objects are placed. The unit will also discuss the pre-testing of data as well as the concepts of reliability and validity.

10.1 OBJECTIVES

After going through this unit, you will be able to:

- Describe the various techniques of scaling
- Discuss pre-testing of data collection tools
- Examine the concepts of validity and reliability

10.2 SCALING TECHNIQUES: MEANING, IMPORTANCE, AND CLASSIFICATION

The scaling techniques used in research can also be classified into comparative and non-comparative scales (Figure 10.1).

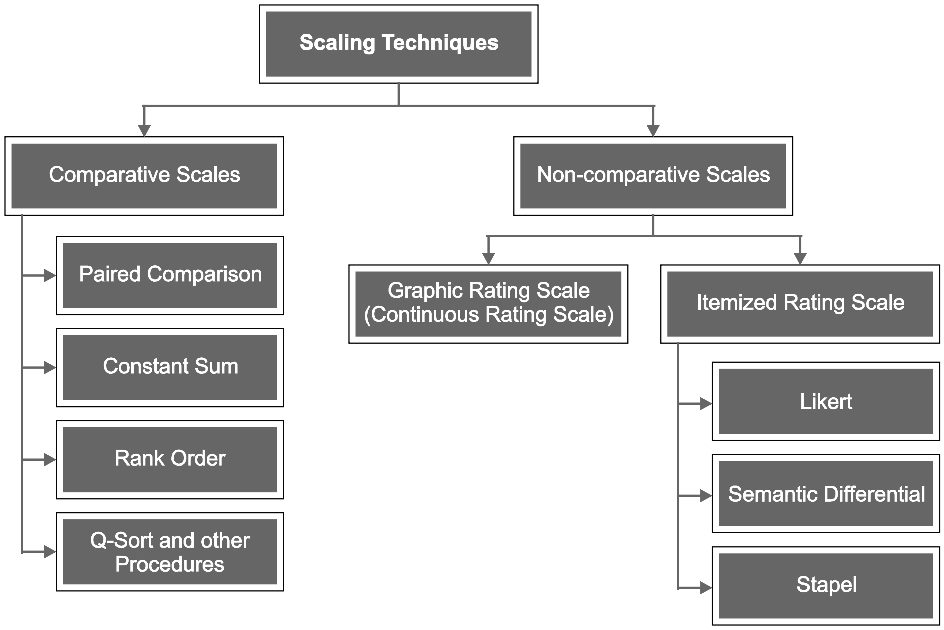


Fig. 10.1 *Types of Scaling*

Comparative scales

In comparative scales it is assumed that respondents make use of a standard frame of reference before answering the question. For example:

A question like 'How do you rate Barista in comparison to Cafe Coffee Day on quality of beverages?' is an example of the comparative rating scale. It involves the direct comparison of stimulus objects. For example, respondents may be asked whether they prefer Chinese or Indian food. Consider the following set of questions generally used to compare various attributes of Domino's Pizza and Pizza Hut.

- Please rate Domino's in comparison to Pizza Hut on the basis of your satisfaction level on an 11-point scale, based on the following parameters: (1 = Extremely poor, 6 = Average, 11 = Extremely good). Circle your response:

a.	Variety of menu options	1	2	3	4	5	6	7	8	9	10	11
b.	Value for money	1	2	3	4	5	6	7	8	9	10	11
c.	Speed of service (delivery time)	1	2	3	4	5	6	7	8	9	10	11
d.	Promotional offers	1	2	3	4	5	6	7	8	9	10	11
e.	Food quality	1	2	3	4	5	6	7	8	9	10	11
f.	Brand name	1	2	3	4	5	6	7	8	9	10	11
g.	Quality of service	1	2	3	4	5	6	7	8	9	10	11

NOTES

h.	Convenience in terms of takeaway location	1	2	3	4	5	6	7	8	9	10	11
i.	Friendliness of the salesperson on the phone	1	2	3	4	5	6	7	8	9	10	11
j.	Quality of packaging	1	2	3	4	5	6	7	8	9	10	11
k.	Adaptation of Indian taste	1	2	3	4	5	6	7	8	9	10	11
l.	Side orders/appetizers	1	2	3	4	5	6	7	8	9	10	11

Comparative scale data is interpreted generally in a relative kind. The comparative scale includes paired comparison, rank order, constant sum scale and Q-sort technique to mention a few.

We will discuss below each of the scale under comparative rating scales in detail below:

Paired comparison scales: Here a respondent is presented with two objects and is asked to select one according to whatever criterion he or she wants to use. The resulting data from this scale is ordinal in nature. As an example, suppose a parent wants to offer one of the four items to a child—chocolate, burger, ice cream and pizza. The child is offered to choose one out of the two from the six possible pairs, i.e., chocolate or burger, chocolate or ice cream, chocolate or pizza, burger or ice cream, burger or pizza and ice cream or pizza. In general, if there are n items, the number of paired comparison would be $(n(n-1)/2)$. Paired comparison technique is useful when the number of items is limited because it requires a direct comparison and overt choice. In case the number of items to be compared is large (say 10), it would result in 45 paired comparisons which would further result in fatigue for the respondents. Further, in reality a respondent does not make the choice from two items at a time—there are multiple alternatives available to him.

There are many ways of analysing the paired comparison data. The analysis of paired comparison data would result in an ordinal scale and also in an interval scale measurement. This will be shown with the help of an example. Let us assume that there are five brands—A, B, C, D and E—and a paired comparison with two brands at a time is presented to the respondent with the option to choose one of them. As there are five brands, it will result in 10 paired comparisons. Suppose this is administered to a sample of 250 respondents with the results as presented in Table 10.1.

NOTES

Table 10.1 *Paired Comparison Data*

	A	B	C	D	E
A	–	0.60	0.30	0.60	0.35
B	0.40	–	0.28	0.70	0.40
C	0.70	0.72	–	0.65	0.10
D	0.40	0.30	0.35	–	0.42
E	0.65	0.60	0.90	0.58	–

The above table may be interpreted by assuming that the cell entry in the matrix represents the proportion of respondents who believe that 'the column brand is preferred over the row brand'. For example:

In brand A versus brand B comparison it can be said that 60 per cent of the respondents prefer brand B to brand A. Similarly, 30 per cent of the respondents prefer brand C to brand A and so on.

To develop the ordinal scale from the given paired comparison data in the above table, we can convert the entries in the table to 0 – 1 scores. This is to show whether the column brand dominates the row brand and vice versa. If the proportion is greater than 0.5 in the above table, a number of '1' is assigned to that cell, which means that the column brand is preferred over the row brand. Whenever the proportion is less than 0.5 in above table, a number of '0' is assigned to that cell, which means column brand does not dominate the row brand. The results are in Table 10.2.

To get the ordinal relationship among the brands, we total the columns. Here the ordinal scale of brands is D > B > A > C > E. This means brand D is the most preferred brand, followed by B, A, C and E.

Table 10.2 *Conversion of Paired Comparison Data into 0 to 1 Form*

	A	B	C	D	E
A	–	1	0	1	0
B	0	–	0	1	0
C	1	1	–	1	0
D	0	0	0	–	0
E	1	1	1	1	–
Total	2	3	1	4	0

In order to obtain the interval scale data from the paired comparison data as presented above, the entries in the table can be analysed by using a technique called Thurston's law of comparative judgement, which converts the ordinal judgements into the interval data. Here the proportions are

NOTES

assumed as probabilities and using the assumption of normality, Z-scores can be computed. Z-value has symmetric distribution with a mean of '0' and variance of '1'. If the proportion is less than 0.5, the corresponding Z-value has a negative sign and for the proportion that is greater than 0.5, the Z-score takes a positive value. The Z-scores for the paired comparison data is given in Table 10.3.

Table 10.3 *Z-scores for Paired Comparison Data*

	A	B	C	D	E
A	0	0.255	–0.525	0.255	–0.38
B	–0.255	0	–0.58	0.525	–0.255
C	0.525	0.58	0	0.385	–1.28
D	–0.255	–0.525	–0.385	0	–0.2
E	0.38	0.255	1.28	0.2	0
Total Distance	0.395	0.565	–0.21	1.365	–2.115
Average Distance	0.079	0.113	–0.042	0.273	–0.423
Brand	D	B	A	C	E
Interval scale value with change of origin	0.696	0.536	0.502	0.381	0

The entries in Table 10.3 show the distance between two brands. Assuming that the scores can be added, the total distance is computed. The average distance is computed by dividing the total score by the number of brands. This way one obtains the absolute position of each brand. Now the highest negative values among all the column is added to each entry corresponding to the average value so that by change of origin, interval scale values can be obtained. This is shown in the last row and the values are of interval scale, indicating the difference between brands. Brand D is the most preferred brand and E is the least preferred brand and the distance between the two is 0.696. The distance between brand C and E equals 0.381.

Rank order scaling: In the rank order scaling, respondents are presented with several objects simultaneously and asked to order or rank them according to some criterion. Consider, for example the following question:

- Rank the following soft drinks in order of your preference, the most preferred soft drink should be ranked one, the second most preferred should be ranked two and so on.

Soft Drinks	Rank
Coke	
Pepsi	
Limca	
Sprite	
Mirinda	
Seven Up	
Fanta	

Like paired comparison, this approach is also comparative in nature. The problem with this scale is that if a respondent does not like any of the above-mentioned soft drink and is forced to rank them in the order of his choice, then, the soft drink which is ranked one should be treated as the least disliked soft drink and similarly, the other rankings can be interpreted. This scale is very commonly used to measure preferences for brands as well as attributes. The rank order scaling results in the ordinal data.

Constant sum rating scaling: In constant sum rating scale, the respondents are asked to allocate a total of 100 points between various objects and brands. The respondent distributes the points to the various objects in the order of his preference. Consider the following example:

- Allocate a total of 100 points among the various school into which you would like to admit your child. The more the points you allocate to a school, more preferred it is considered to be. The points should be allocated in such a way that the sum total of the points allocated to various schools adds up to 100.

Schools	Points
DPS	
Modern School	
Mother's International	
APEEJAY	
DAV Public School	
Laxman Public School	
Tagore International	
TOTAL POINTS	**100**

Suppose Mother's International is awarded 30 points, whereas Laxman Public School is awarded 15 points, one can make a statement that the respondent rates Mother's International twice as high as Laxman Public School. This type of data is not only comparative in nature but could also result

in ratio scale measurement. This type of scale is widely used in allocating weights which the consumer may assign to the various attributes of a product.

Q-sort technique: The Q-sort technique was developed to discriminate among a large number of objects quickly. This technique makes use of the rank order procedure in which objects are sorted into different piles based on their similarity with respect to certain criterion. Suppose there are 100 statements and an individual is asked to pile them into five groups, in such a way, that the strongly agreed statements could be put in one pile, agreed statements could be put in another pile, neutral statement form the third pile, disagreed statements come in the fourth pile and strongly disagreed statements form the fifth pile, and so on. The data generated in this way would be ordinal in nature. The distribution of the number of statement in each pile should be such that the resulting data may follow a normal distribution. The number of piles need not be restricted to 5. It could be as large as 10 or more as the large number increases the reliability or precision of the results.

Non-comparative scales

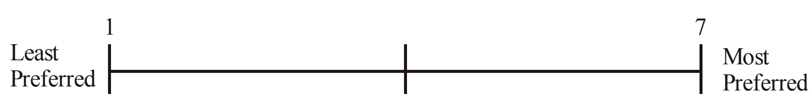
In the non-comparative scales, the respondents do not make use of any frame of reference before answering the questions. The resulting data is generally assumed to be interval or ratio scale. For example:

The respondent may be asked to evaluate the quality of food in a restaurant on a five point scale (1 = very poor, 2 = poor and 5 = very good). The non-comparative scales are divided into two categories, namely, the graphic rating scales and the itemized rating scales. The itemized rating scales are further divided into Likert scale, semantic differential scale and Stapel scale. All these come under the category of the multiple item scales.

Graphic rating scale

This is a continuous scale, also called graphic rating scale. In the graphic rating scale the respondent is asked to tick his preference on a graph. Consider for example the following question:

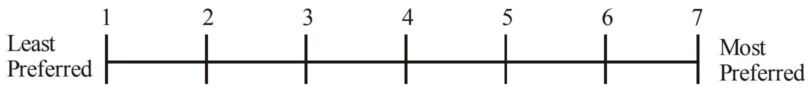
- Please put a tick mark (•) on the following line to indicate your preference for fast food.



To measure the preference of an individual towards the fast food one has to measure the distance from the extreme left to the position where a tick mark has been put. Higher the distance, higher would be the individual preference for fast food. This scale suffers from two limitations—one, if a respondent has put a tick mark at a particular position and after ten minutes, he or she is given another form to put a tick mark, it will virtually be impossible

to put a tick at the same position as was done earlier. Does it mean that the respondent's preference for fast food has undergone a change in10 minutes? The basic assumption in this scale is that the respondents can distinguish the fine shade in differences between the preference/attitude which need not be the case. Further, the coding, editing and tabulation of data generated through such a procedure is a very tedious task and researchers would try to avoid using it. Another version of graphic scale could be the following:

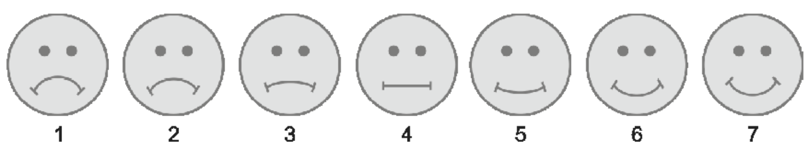
- Please put a tick mark (•) on the following line to indicate your preference for fast food.



This is a slightly better version than the one discussed earlier. It will overcome the limitation of the scale to some extent. For example, if a respondent had earlier ticked between 5 and 6, it is likely that he would remember the same and the second time, he would tick very close to where he did earlier. This means that the difference in the two responses could be negligible.

Another way of presenting the graphic rating scale is through smiling face scale. The following example would illustrate the same.

- Please indicate how much do you like fast food by pointing to the face that best shows your attitude and taste. If you do not prefer it at all, you would point to face one. In case you prefer it the most, you would point to face seven.



Itemized rating scale

In the itemized rating scale, the respondents are provided with a scale that has a number of brief descriptions associated with each of the response categories. The response categories are ordered in terms of the scale position and the respondents are supposed to select the specified category that describes in the best possible way an object is rated. Itemized rating scales are widely used in survey research. There are certain issues that should be kept in mind while designing the itemized rating scale. These issues are:

Number of categories to be used: There is no hard and fast rule as to how many categories should be used in an itemized rating scale. However, it is a practice to use five or six categories. Some researchers are of the opinion that more than five categories should be used in situations where small changes in

NOTES

attitudes are to be measured. There are others that argue that the respondents would find it difficult to distinguish between more than five categories. It is, however, a fact that the additional categories need not increase the precision with the attitude being measured. It is generally seen that researchers use five-category scales and in special cases, may increase or decrease the number of categories.

Odd or even number of categories: It has been a matter of debate among the researchers as to whether odd or even number of categories are to be used in survey research. By using even number of categories the scale would not have a neutral category and the respondent will be forced to choose either the positive or the negative side of the attitude. If odd numbers of categories are used, the respondent has the freedom to be neutral if he wants to be so. The Likert scale (to be discussed later) is a balanced rating scale with an odd number of categories and a neutral point. It is generally seen that if a respondent is not aware of the subject matter being measured by the scale, he would prefer to be neutral. However, if we have selected our unit of analysis to be one who is knowledgeable about the study being conducted and if he prefers to be neutral, we should not debar him from this opportunity.

Balanced versus unbalanced scales: A balanced scale is the one which has equal number of favourable and unfavourable categories. Examples of balanced and unbalanced scale are given below. The following is the example of a balanced scale:

- How important is price to you in buying a new car?

  Very important

  Relatively important

  Neither important nor unimportant

  Relatively unimportant

  Very unimportant

  In this question, there are five response categories, two of which emphasize the importance of price and two others that do not show its importance. The middle category is neutral.

The following is the example of the unbalanced scale.

- How important is price to you in buying a new car?

  More important than any other factor

  Extremely important

  Important

  Somewhat important

  Unimportant

NOTES

In this question there are four response categories that are skewed towards the importance given to the price, whereas one category is for the unimportant side. Therefore, this question is an unbalanced question. In the unbalanced scale, the numbers of favourable and unfavourable categories are not the same. One could use an unbalanced scale depending upon the nature of attitude distribution to be measured. If the distribution is dominantly favourable, an unbalanced scale with more favourable categories than unfavourable categories should be appropriate. If an unbalanced scale is used, the nature and degree of the unbalance in the scale should be taken into account during the data analysis.

Nature and degree of verbal description: Many researchers believe that each category must have a verbal, numerical or pictorial description. Verbal description should be clearly and precisely worded so that the respondents are able to differentiate between them. Further, the researcher must decide whether to label every scale category, some scale categories, or only extreme scale categories. It is argued that a clearly defined response category increases the reliability of the measurement.

Forced versus non-forced scales: An important issue concerning the construction of an itemized rating scale is the use of a forced scale versus non-forced scale. In the forced scale, the respondent is forced to take a stand, whereas in the non-forced scale, the respondent can be neutral if he/she so desires. The argument for a forced scale is that those who are reluctant to reveal their attitude are encouraged to do so with the forced scale. Paired comparison scale, rank order scale and constant sum rating scales are examples of forced scales.

Physical form: There are many options that are available for the presentation of the scales. It could be presented vertically or horizontally. The categories could be expressed in boxes, discrete lines or as units on a continuum. They may or may not have numbers assigned to them. The numerical values, if used, may be positive, negative or both.

Suppose we want to measure the perception about Jet Airways using a multi-item scale. One of the questions is about the behaviour of the crew members. Given below is a set of scale configurations that may be used to measure their behaviour. The following are some of the examples where various forms of presenting the scales are shown:

The behaviour of the crew members of Jet Airways is:

1. Very bad _____ _____ _____ _____ _____ Very good
2. Very bad 1 2 3 4 5 Very good
3. ☐ Very bad
   ☐

☐ Neither bad nor good

☐

☐ Very good

NOTES

4. Very bad Bad Neither bad nor good Good Very good

5. –2 –1 0 1 2

Very bad Neither bad nor good Very good

Below we will describe some of the itemized rating scales which are very commonly used in survey research.

Likert scale: This is a multiple item agree–disagree five-point scale. The respondents are given a certain number of items (statements) on which they are asked to express their degree of agreement/disagreement. This is also called a summated scale because the scores on individual items can be added together to produce a total score for the respondent. An assumption of the Likert scale is that each of the items (statements) measures some aspect of a single common factor, otherwise the scores on the items cannot legitimately be summed up. In a typical research study, there are generally 25 to 30 items on a Likert scale.

To construct a Likert scale to measure a particular construct, a large number of statements pertaining to the construct are listed. These statements could range from 80 to 120. The identification of the statements is done through exploratory research which is carried out by conducting a focus group, unstructured interviews with knowledgeable people, literature survey, analysis of case studies and so on. Suppose we want to assess the image of a company. As a first step, an exploratory research may be conducted by having an informal interview with the customers, and employees of the company. The general public may also be contacted. A survey of the literature on the subject may also give a set of information that could be useful for constructing the statements. Suppose the number of statements to measure the constructs is 100 in number. Now samples of representative respondents are asked to state their degree of agreement/disagreement on those statements. Table 10.4 gives a few statements to assess the image of the company.

It may be noted that only anchor labels and no numerical values are assigned to the response categories. Once the scale is administered, numerical values are assigned to the response categories. The scale contains statements' some of which are favourable to the construct we are trying to measure and some are unfavourable to it.

For example, out of the ten statements given, statements numbering 1, 2, 4, 6 and 9 in Table 10.4 are favourable statements, whereas the remaining are unfavourable statements. The reason for having a mixture of favourable and unfavourable statements in a Likert scale is that the responses by the respondent should not become monotonous while answering the questions.

NOTES

Generally, in a Likert scale, there is an approximately equal number of favourable and unfavourable statements. Once the scale is administered, numerical values are assigned to the responses. The rule is that a 'strongly agree' response for a favourable statement should get the same numerical value as the 'strongly disagree' response of the unfavourable statement. Suppose for a favourable statement the numbering is done as Strongly disagree = 1, Disagree = 2, Neither agree nor disagree = 3, Agree = 4 and Strongly agree = 5. Accordingly, an unfavourable statement would get the numerical values as Strongly disagree = 5, Disagree = 4, Neither agree nor disagree = 3, Agree = 2 and Strong agree = 1. In order to measure the image that the respondent has about the company, the scores are added.

Table 10.4 *Likert Scale Statements to Measure the Image of the Company*

No.	Statement	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1.	The company makes quality products			√		
2.	It is a leader in technology					√
3.	It doesn't care about the general public.		√			
4.	The company leads in R&D to improve products				√	
5.	The company is not a good paymaster.	√				
6.	The products of the company go through stringent quality tests.				√	
7.	The company has not done anything to curb pollution.		√			
8.	It does not care about the community near its plant.	√				
9.	The company's stocks are good to buy or own.				√	
10.	The company does not have good labour relations.		√			

For example, if a respondent has ticked (√) statements numbering from one to ten as shown in Table 10.4, his total score would be 3 + 5 + 4 + 4 + 5 + 4 + 4 + 5 + 4 + 4 = 42 out of 50. Now if there are 100 respondents and 100 statements, the score on the image of the company can be worked out for each respondent by adding his/her scores on the 100 statements.

The minimum score for each respondent will be 100, whereas the maximum score would be 500.

NOTES

As mentioned earlier, a typical Likert scale comprises about 25–30 statements. In order to select 25 statements from the 100 statements, we need to discard some of them. The rule behind discarding the statements is that those items that are non-discriminating should be removed. The procedure for choosing 25 (say number of statements) is shown.

As mentioned earlier, the score for each of the respondents on each of the statements can be used to measure his/her total score about the image of the company. The data may look as given in Table 10.5.

Table 10.5 shows that the total score for respondent no. 1 is 410, whereas for respondent no. 2 it is 209. This means that respondent no. 1 has a more favourable image for the company as compared to respondent no. 2. Now, in order to select 25 statements, let us consider statements numbering i and j. We note that the statement no. j is more discriminating as compared to statement no. i. This is because the score on statement j is very highly correlated with the total score as compared to the scores on statement i. Therefore, if we have to choose between i and j, we will choose statement no. j. From this we can conclude that only those statements will be selected which have a very high correlation with the total score. Therefore, the 100 correlations are to be arranged in the ascending order of magnitudes corresponding to each statement and only top 25 statements having a high correlation with the total score need to be selected.

Table 10.5 *Total Score and Individual Score of each Respondent on Various Statements*

Scores of Statements										
Resp. No.	**1**	**2**	**3**	**...........**	**i**	**...........**	**j**	**...........**	**100**	**Total Score**
1	-	-	-	....	5	....	4	....	-	410
2	-	-	-	....	4	....	2	....	-	209
3	-	-	-	....	-	....	-	....	-	-
-	-	-	-	....	-	....	-	....	-	-
-	-	-	-	....	-	....	-	....	-	-
-	-	-	-	....	-	....	-	....	-	-
-	-	-	-	....	-	....	-	....	-	-
-	-	-	-	....	-	....	-	....	-	-
-	-	-	-	....	-	....	-	....	-	-
100	-	-	-	....	-	....	-	....	-	-

Another method of selecting the number of statements from a relatively large number of them is through the use of factor analysis. This aspect will be covered at the appropriate stage in the unit on factor analysis.

Semantic differential scale: This scale is widely used to compare the images of competing brands, companies or services. Here the respondent is required to rate each attitude or object on a number of five-or seven-point rating scales. This scale is bounded at each end by bipolar adjectives or phrases. The difference between Likert and Semantic differential scale is that in Likert scale, a number of statements (items) are presented to the respondents to express their degree of agreement/disagreement. However, in the semantic differential scale, bipolar adjectives or phrases are used. As in the case of Likert scale, the information on the phrases and adjectives is obtained through exploratory research. At times there may be a favourable or unfavourable descriptor (adjectives) on the right-hand side and on certain occasions these may be presented on the left-hand side. This rotation becomes necessary to avoid the halo effect. This is because the location of previous judgments on the scale may influence the subsequent judgements because of the carelessness of the respondents. The mid point of a bipolar scale is a neutral point. In the Likert scale, ten statements were used where respondents were asked to express their degree of agreement/disagreement regarding the image of the company. Taking the same example further, the semantic differential scale corresponding to those ten statements in Likert scale is shown below where the bipolar adjectives/phrases are separated by seven points. These points can be numbered as 1, 2, 3, ..., 7 or +3, +2, +1, 0, –1, ..., –3 – for a favourable descriptor positioned on the left hand side. For an unfavourable descriptor the numberings would be reversed. A typical semantic differential scale where bipolar adjectives/phrases are positioned at the two extreme ends is given in Table 10.6.

Table 10.6 *Select Bipolar Adjectives/Phrases of Semantic Differential Scale*

1	Makes quality products		Does not make quality products
2	Leader in technology		Backward in technology
3	Does not care about general public		Cares about general public
4	Leads in R & D		Lagging behind in R&D
5	Not a good paymaster		A good paymaster
6	Products go through stringent quality test		Products don't go through quality test
7	Does nothing to curb pollution		Does a remarkable job in curbing pollution
8	Does not care about community near plants		Cares about community near plants
9	Company stocks good to buy		Not advisable to invest in company stock
10	Does not have good labour relations		Has good labour relations

Once the scale is constructed and administered to the representative respondents, the mean score for each of the descriptor is calculated. The scale is administered under the assumption that the numerical values assigned to the response categories are of interval scale in nature. This is generally the practice adopted by many researchers. However, if the response categories are treated as ordinal scale, instead of computing the arithmetic mean, median may be computed. In this example, we are treating the responses as the interval scale and hence the mean is computed. Once the mean for all the bipolar adjectives/phrases is computed we put the result in the form of a pictorial profile so as to make the comparison easy. At this time, all the favourable descriptors are kept on one side and all the unfavourable descriptors are positioned at the other. In our example, we have positioned all the favourable descriptors for the two companies whose image we want to compare on the left hand side. This is shown in Table 10.7.

Table 10.7 *Pictorial Profile based on Semantic Differential Ratings*

1	Makes quality products		Does not make quality products
2	Leader in technology		Backward in technology
3	Cares about general public		Does not care about general public
4	Leads in R & D		Lagging behind in R&D
5	A good paymaster		Not a good paymaster
6	Products go through stringent quality test		Products do not go through quality test
7	Done remarkable job in curbing pollution		Done nothing to curb pollution
8	Cares about community near plants		Does not care about community near plants
9	Company stocks good to buy		Not advisable to invest in company stock
10	Has good labour relations		Does not have good labour relations

Company A ______________________________________ Company B

As per the results presented in the pictorial profile, Company A is better than Company B in the sense that it makes quality products, leads in R&D, its products go through stringent quality tests, its stocks are good to buy and it has good labour relations. Company B is ahead of Company A as it cares about general public and is a good paymaster. Company A is a better than Company B as it is leads in technology whereas Company B is better than

Company A as it has done a remarkable job in curbing pollution. However, these differences are not statistically significant.

Stapel scale: The Stapel scale is used to measure the direction and intensity of an attitude. At times it, may be difficult to use semantic differential scales because of the problem in creating bipolar adjectives. The Stapel scale overcomes this problem by using only single adjectives. This scale generally has 10 categories involving numbering –5 to +5 without a neutral point and is usually presented in a vertical form. The job of the respondent is to indicate how accurately or inaccurately each term describes the object by selecting an appropriate numerical response category. If a positive higher number is selected by the respondent, it means the respondent is able to describe it more favourably. Suppose a restaurant is to be evaluated on quality of food and quality of service, then the Stapel scale would be presented as shown below:

RESTAURANT

+5	+5
+4	+4
+3	+3
+2*	+2
+1	+1
Quality of Food	***Quality of Service***
–1	–1
–2	–2
–3	–3
–4	–4
–5	–5*

In the above scale, the respondents are asked to evaluate how accurately each word or phrase describes the restaurant in question. They will choose a value of +5 if the restaurant very accurately describes the attribute and –5 if it does not describe at all correctly the word in question. Suppose a respondent has chosen his options as indicated by*. This shows that the respondent slightly prefers the quality of food and is of the opinion that the quality of service is totally useless.

10.2.1 Types of Measurement Scales: Nominal, Ordinal, Interval and Ratio

There are four types of measurement scales—nominal, ordinal, interval and ratio scales. We will discuss each one of them in detail. The choice of the measurement scale has implications for the statistical technique to be used for data analysis.

Nominal scale: This is the lowest level of measurement. Here, numbers are assigned for the purpose of identification of the objects. Any object which is assigned a higher number is in no way superior to the one which is assigned a lower number. In the nominal scale there is a strict one-to-one correspondence between the numbers and the objects. Each number is assigned to only one object and each object has only one number assigned to it. It may be noted that the objects are divided into mutually exclusive and collectively exhaustive categories.

Examples of nominal scale:

- What is your religion?
  - (a) Hinduism
  - (b) Sikhism
  - (c) Christianity
  - (d) Islam
  - (e) Any other, (please specify)

A Hindu may be assigned a number 1, a Sikh may be assigned a number 2, a Christian may be assigned a number 3 and so on. Any religion which is assigned a higher number is in no way superior to the one which is assigned a lower number. The assignment of numbers is only for the purpose of identification. We also note that all respondents have been divided into mutually exclusive and collectively exhaustive categories. For example:

- Are you married?
  - (a) Yes
  - (b) No

If a person is married, he or she may be assigned a number 101 and an unmarried person may be assigned a number 102.

- In which of the following departments do you work?
  - (a) Marketing
  - (b) HR
  - (c) Information Technology
  - (d) Operations
  - (e) Finance and Accounting
  - (f) Any other, (please specify)

Here also, a person working for the marketing department may be assigned a number 1, the one working for HR may be assigned a number 2 and so on.

Nominal scale measurements are used for identifying food habits (vegetarian or non-vegetarian), gender (male/female), caste, respondents, brands, attributes, stores, the players of a hockey team and so on.

The assigned numbers cannot be added, subtracted, multiplied or divided. The only arithmetic operations that can be carried out are the count of each category. Therefore, a frequency distribution table can be prepared for the nominal scale variables and mode of the distribution can be worked out. One can also use chi-square test and compute contingency coefficient using nominal scale variables.

Ordinal scale: This is the next higher level of measurement than the nominal scale measurement. One of the limitations of the nominal scale measurements is that we cannot say whether the assigned number to an object is higher or lower than the one assigned to another option. The ordinal scale measurement takes care of this limitation. An ordinal scale measurement tells whether an object has more or less of characteristics than some other objects. However, it cannot answer how much more or how much less. An ordinal scale tells us the relative positions of the objects and not the difference between the magnitudes of the objects. Suppose Shashi scores the highest marks in marketing and is ranked no. 1; Mohan scores the second highest marks and is ranked no. 2; and Krishna scores third highest marks and is ranked no. 3. However, from this statement we cannot say whether the difference in the marks scored by Shashi and Mohan is the same as between Mohan and Krishna. The only statement which can be made under ordinal scale is that Shashi has scored higher than Mohan and Mohan has scored higher than Krishna. The difference between the ranks does not have any meaningful interpretation in the sense that it cannot tell the difference in absolute marks between the three candidates. Another example of the ordinal scale could be the CAT score given in percentile form. Suppose a candidate's score is 95 percentile in the CAT exam. What it means is that 95 per cent of the candidates that appeared in the CAT examination have a score below this candidate, whereas only 5 per cent have scored more than him. The actual score is how much less or more cannot be known from this statement. Examples of the ordinal scale include quality ranking, rankings of the teams in a tournament, ranking of preference for colours, soft drinks, socio-economic class and occupational status, to mention a few. Some of the examples of ordinal scales are listed below:

- Rank the following attributes while choosing a restaurant for dinner. The most important attribute may be ranked one, the next important may be assigned a rank of 2 and so on.

Attribute	Rank
Food quality	
Prices	
Menu variety	
Ambience	
Service	

- Rank the following by placing a 1 beside the attribute you think is the most important, a 2 beside the attribute you think is the second most important and so on while purchasing a two-wheeler.

Attribute	Rank
After sale service	
Prices	
Re-sale value	
Fuel efficiency	
Aesthetic appeal	

In the ordinal scale, the assigned ranks cannot be added, multiplied, subtracted or divided. One can compute median, percentiles and quartiles of the distribution. The other major statistical analysis which can be carried out is the rank order correlation coefficient, sign test. As the ordinal scale measurement is higher than the nominal scale measurement, all the statistical techniques which are applicable in the case of nominal scale measurement can also be used for the ordinal scale measurement. However, the reverse is not true. This is because ordinal scale data can be converted into nominal scale data but not the other way round.

Interval scale: The interval scale measurement is the next higher level of measurement. It takes care of the limitation of the ordinal scale measurement where the difference between the score on the ordinal scale does not have any meaningful interpretation. In the interval scale the difference of the score on the scale has meaningful interpretation. It is assumed that the respondent is able to answer the questions on a continuum scale. The mathematical form of the data on the interval scale may be written as

$$Y = a + bX \qquad \text{where } a \neq 0$$

The interval scale data has an arbitrary origin (non-zero origin). The most common example of the interval scale data is the relationship between Celsius and Farenheit temperature. It is known that:

$$C° = \frac{5}{9}(F° - 32).$$

Therefore,

$$C° = \frac{-160}{9} + \frac{5}{9}F°$$

This is of the form $Y = a + bX$, where $a = \frac{-160}{9}$ and $b = \frac{5}{9}$ and hence it represents the interval scale measurement. In the interval scale, the difference in score has a meaningful interpretation while the ratio of the score on this

scale does not have a meaningful interpretation. This can be seen from the following interval scale question:

- How likely are you to buy a new designer carpet in the next six months?

	Very unlikely	Unlikely	Neutral	Likely	Very likely
Scale A	1	2	3	4	5
Scale B	0	1	2	3	4
Scale C	–2	–1	0	1	2

Suppose a respondent ticks the response category 'likely' and another respondent ticks the category 'unlikely'. If we use any of the scales A, B or C, we note that the difference between the scores in each case is 2. Whereas, when the ratio of the scores is taken, it is 2, 3 and –1 for the scales A, B and C respectively. Therefore, the ratio of the scores on the scale does not have a meaningful interpretation. The following are some examples of interval scale data.

- How important is price to you while buying a car?

Least important	Unimportant	Neutral	Important important	Most
1	2	3	4	5

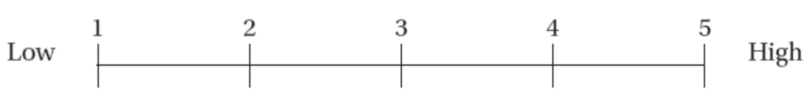
- How do you rate the work environment of your organization?

Very good	Good	Neither good nor bad	Bad	Very bad
5	4	3	2	1

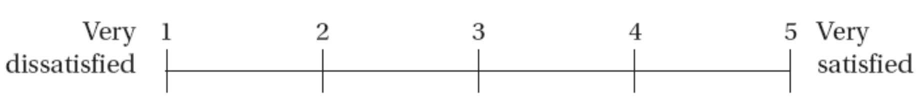
- The counter-clerks at ICICI Bank, (Vasant Kunj Branch) are very friendly.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1	2	3	4	5

- Rate the life of the battery of your inverter.



- Indicate the degree of satisfaction with the overall performance of Wagon R.



NOTES

- How expensive is the restaurant 'Punjabi By Nature'?

Extremely expensive	Definitely expensive	Somewhat expensive	Somewhat inexpensive	Definitely inexpensive	Extremely inexpensive
1	2	3	4	5	6

- How likely are you to buy a new car within the next six months?

Definitely will buy	Probably will buy	Neutral	Probably will not buy	Definitely will not buy
1	2	3	4	5

The numbers on this scale can be added, subtracted, multiplied or divided. One can compute arithmetic mean, standard deviation, correlation coefficient and conduct a t-test, Z-test, regression analysis and factor analysis. As the interval scale data can be converted into the ordinal and the nominal scale data, therefore all the techniques applicable for the ordinal and the nominal scale data can also be used for interval scale data.

Ratio scale: This is the highest level of measurement and takes care of the limitations of the interval scale measurement, where the ratio of the measurements on the scale does not have a meaningful interpretation. The ratio scale measurement can be converted into interval, ordinal and nominal scale. But the other way round is not possible. The mathematical form of the ratio scale data is given by $Y = bX$. In this case, there is a natural zero (origin), whereas in the interval scale we had an arbitrary zero. Examples of the ratio scale data are weight, distance travelled, income and sales of a company, to mention a few.

10.3 METHODS OF CONSTRUCTION OF QUESTIONNAIRES OR SCHEDULES

We have already discussed the method of construction of questionnaires and schedules in Unit 9. To briefly recapitulate what we have discussed, the steps involved in designing a questionnaire encompass the following: (1) convert the research objectives into the information needed, (2) Method of administering the questionnaire, (3) Content of the questions, (4) Motivating the respondent to answer, (5) Determining the types of questions, (6) Question design criteria, (7) Determine the questionnaire structure, (8) Physical presentation of the questionnaire, (9) Pilot testing the questionnaire, (10) Standardizing the questionnaire.

Check Your Progress

1. How can scaling techniques used in research be classified?
2. List the four types of measurement scales.
3. What are some examples of ratio scale data?

10.4 PRE-TESTING OF DATA COLLECTION TOOLS

NOTES

Pre-test is a trial test of a specific aspect of the study, such as the common methods of data collection or common data collection tools—schedule (used as tool for interviewing), questionnaire or measurement scale. It is the administration of the data collection instrument with a small set of respondents from the population for the full scale survey. If problems happen in the pre-test, the researcher is likely to face similar problems in full-scale administration. Pre-testing aims at identifying problems with the data collection instrument and find possible solutions. Pre-testing needs to be carried out in circumstances that are as akin as possible to actual data collection and as identical as possible to those that will be sampled.

Survey sponsors have a major role to play in developing the data collection instruments being proposed, including any testing being carried out. Much of the accuracy and interpretability of the survey results depends on pre-testing, which should never be ignored.

Need for pre-testing

An instrument of data collection is designed in accordance with the data requirements of the study. However, any scrutiny by the designer and other researchers cannot make the instrument perfect. It needs to be tested empirically. As pointed by Goode and Hatt: 'No amount of thinking, no matter how logical the mind or brilliant the insight, is likely to take the place of careful empirical checking.' Thus, pre-testing of a draft instrument is essential.

Purpose of pre-testing

Pre-testing aims at:

- Testing whether the instrument would draw out responses needed to achieve the research objectives
- Developing a suitable procedure to administer the instrument with reference to field conditions
- Testing whether wording of questions is unambiguous and suited to the understanding of the respondents
- Testing whether the content of the instrument is applicable and sufficient
- Testing the other qualitative aspects of the instrument, such as question structure and question sequence

Pre-Testing of Questionnaire

- Pilot testing refers to testing and administering the designed instrument on a small group of people from the population under study. This is to essentially cover any errors that might have still remained even after the earlier eight steps.

NOTES

- Every aspect of the questionnaire has to be tested and one must record all the experiences of the conduction, including the time taken to administer it. If the respondent had a problem understanding a question or response category, the investigator should verbatim record the instruction he/she gave to clarify the point as this then would need to be incorporated in the final version of the questionnaire.
- In case a question got no answers, then it might be essential to rephrase the entire question.
- Even when the mode of administration is mail or Internet or self-administered tests, the pilot tests should always be done in a face-to-face interaction. Here, the researcher is able to observe and record responses, both verbal and non-verbal.
- Sometimes, the researcher might also get the questionnaire vetted by academic or industry experts for their inputs.
- Once the essential changes have been made, the researcher might carry out one short trial and then go ahead with the actual administration.
- As far as possible, the pilot should be a small scale replica of the actual survey that would be subsequently conducted.
- It is advisable to use multiple investigators for the pilot study.
- The group of investigators should be a mix of experienced and seasoned field investigators and inexperienced investigators as well.
- The inexperienced ones would be able to reveal the problems encountered in administering the measure, while the experienced field workers would be able to report respondent difficulties in answering the questions.
- The respondent's experience of the pilot test can be recorded in two ways. One is protocol analysis where he is asked to speak out the reasoning in responding to the questions. This is recorded, as it helps to understand the underlying factors or mental processing involved in giving answers.
- The other method is called debriefing, where after the questionnaire has been completed, the person is asked to summarize his experience in terms of any problems experienced in answering or whether there was any confusion or fatigue while answering the questionnaire.
- The researcher must then edit the questionnaire as required and carry out any further pilot tests. Once this is over, he enters the pilot data to explore and see whether the information that is being collected through the questionnaire would adequately furnish the information needs for which the instrument was designed.

Methods of pre-testing questionnaires

The various methods or techniques of pre-testing questionnaires are listed and discussed as follows:

- **Respondent focus groups:** Focus groups (referred to as a form of in-depth group interviewing) are carried out early in the questionnaire development cycle to evaluate the question-answering process. Such groups may collect information relating to a topic before the beginning of questionnaire construction. They help in the identification of differences in language, terminology, or interpretation of questions and response options. They are especially very useful in pre-testing self-administered questionnaires in order to learn about the appearance and formatting of the questionnaire. One of the major advantages of focus groups is that it provides the opportunity to monitor a great deal of interaction on a topic in a limited time span.
- **Behaviour coding:** Behaviour coding refers to a systematic coding of the interaction between interviewers and respondents from live or taped interviews. It emphasizes on specific aspects of how the interviewer asked the question and how the respondent reacted. When used for pre-testing a questionnaire, the coding highlights interviewer or respondent behaviours indicative of a problem with the question, the response categories, or the respondent's skill to form a satisfactory response.
- **Cognitive laboratory interviews:** Cognitive laboratory interviews comprise one-on-one interviews using a structured questionnaire in which respondents describe their thoughts while giving answers to the survey questions. They provide a vital means of finding out directly from respondents what their problems are with the questionnaire. In addition, small numbers of interviews may give valuable information about major problems, such as repetitions of questions and ambiguous concepts. As sample sizes are not large in cognitive laboratory interviews, repeated pre-testing of an instrument is common.
- **Respondent and interviewer debriefings:** Respondent debriefings involve the incorporation of structured follow-up questions at the end of a field test interview to gather quantitative and qualitative information about respondents' interpretations of survey questions. For the purpose of pre-testing, their prime object is to find out whether the survey concepts and questions are comprehended by respondents in the same way that the survey sponsors intended.

Interviewer debriefings have conventionally been the primary method for evaluating field tests. In this method, the interviewers conducting the survey field tests are queried to use their direct contact with respondents so that the questionnaire designer's understanding of questionnaire problems is enriched.

- **Analysis of item non-response rates:** Analysis of item non-response rates from the data gathered during a field test provides useful information about how well the questionnaire works. This is carried out by looking at how often items are missing (i.e., item non-response rates).
- **Split-panel tests:** Split-panel tests are the controlled experimental testing among questionnaire variants or interviewing modes for determining which is 'better' or for measuring differences between them. In order to pre-test multiple versions of a questionnaire, research requires a previously determined standard by which to judge the differences. Split-panel tests are also useful in standardizing the effect of changing questions, which is particularly significant in the redesign and testing of surveys where the comparability of the data gathered over time is a problem.
- **Analysis of response distributions:** The analysis of response distributions for an item is useful in determining whether different question wordings or question sequences result different response patterns. Such analysis is most useful when the researcher has to pre-test more than one version of a questionnaire or a single questionnaire in which some known distribution of characteristics exists for comparative purposes.

Pre-Testing of Interview Schedule

The pre-testing of interview schedule involves contact with respondents drawn from the same population as for the actual survey. Pre-testing includes the testing of question content, wording, sequence, form and layout, difficulty, instructions and acceptance. On the completion of pre-testing, all necessary changes are made to fix the identified problems. As in any high-quality research plan, a researcher needs to pre-test the interview protocol, or list of interview questions, before collecting data for the main study. In other words, first of all, the researcher conducts a pilot study of his list of interview questions with a group of persons who are demographically similar to his ultimate sample profile. This helps in the determination of the most logical and smooth-flowing order of the questions. Pre-testing also identifies wording issues that need to be addressed for the sake of clarity, which will enhance the integrity of the researcher's data. Last but not the least, a pre-test sheds important light on the amount of time to be taken to conduct the interview, which is one of the first questions the researcher will be asked by potential participants.

10.5 VALIDITY AND RELIABILITY METHODS

There are three criteria for good collection of data: reliability, validity and sensitivity.

1. Reliability

Reliability is concerned with consistency, accuracy and predictability of the scale. It refers to the extent to which a measurement process is free from random errors. The reliability of a scale can be measured using the following methods:

Test–retest reliability: In this method, repeated measurements of the same person or group using the same scale under similar conditions are taken. A very high correlation between the two scores indicates that the scale is reliable. However, the following issues should be kept in mind before arriving at such a conclusion.

- What should be the appropriate time difference between the two observations is a question which requires attention. If the time difference between two consecutive observations is very small (say two or three weeks) it is very likely that the respondents would remember the previous answer and may give the same answer when the instrument is administered the second time. This will make the instrument reliable, which may not actually be the case. However, if the difference between the two observations is very large (say more than a year) it is quite likely that the respondent's answers to the various questions of the instrument might have actually undergone a change, resulting in poor reliability of the scale. Therefore, the researcher has to be very careful in deciding upon the time difference between the two observations. Generally, it is thought that a time difference of about five to six months is an ideal period.
- Another problem in this test is that the first measurement may change the response of the subject to the second measurement.
- The situational factors working on two different time periods may not be the same, which may result in different measurement in the two periods.
- The second reading on the same instrument from the same subject may produce boredom, anger or attempt to remember the answers given in an initial measurement.
- A favourable response with a brand during the period between the two tests might cause a shift in the individual rating by the subject.

Split-half reliability method: This method is used in the case of multiple item scales. Here the number of items is randomly divided into two parts

NOTES

and a correlation coefficient between the two is obtained. A high correlation indicates that the internal consistency of the construct leads to greater reliability. Another measure which is used to test the internal consistency of a multiple item scale is the coefficient alpha (±) commonly known as cronbach alpha. The cronbach alpha computes the average of all possible split-half reliabilities for a multiple item scale. This coefficient demonstrates whether the average score of all split-half of reliabilities converge to a certain point or not.

The coefficient alpha does not address validity. However, many researchers use this as a sole indicator of validity. The alpha coefficient can take values between 0 and 1. The following values of alpha with their interpretation are suggested below:

± = 0 means	There is no consistency between the various items of a multiple item scale
± = 1 means	There is complete consistency between various items of a multiple item scale
$0.80 \leq a \leq 0.95$ implies	There is very good reliability between the various items of a multiple item scale
$0.70 \leq a \leq 0.80$ implies	There is good reliability between the various items of a multiple item scale
$0.60 \leq a \leq 0.70$ implies	There is fair reliability between the various items of a multiple item scale
$a < 0.60$ means	There is poor reliability between the various items of a multiple item scale

2. Validity

The validity of a scale refers to the question whether we are measuring what we want to measure. Validity of the scale refers to the extent to which the measurement process is free from both systematic and random errors. The validity of a scale is a more serious a issue than reliability. There are different ways to measure validity

Content validity: This is also called face validity. It involves subjective judgement by an expert for assessing the appropriateness of the construct. For example, to measure the perception of a customer towards Kingfisher Airlines, a multiple item scale is developed. A set of 15 items is proposed. These items when combined in an index measure the perception of Kingfisher Airlines. In order to judge the content validity of these 15 items, a set of experts may be requested to examine the representativeness of the 15 items. The items covered may be lacking in the content validity if we have omitted behaviour of the crew, food quality, and food quantity, etc., from the list. In

fact, conducting the exploratory research to exhaust the list of items measuring perception of the airline would be of immense help in such a case.

Concurrent validity: It is used to measure the validity of the new measuring techniques by correlating them with the established techniques. It involves computing the correlation coefficient of two measures of the same phenomena (for example, perception of an airline and image of a company) which are administered at the same time. We prepare a 15 item scale to measure the perception of Kingfisher Airline, which is assumed to be a valid one. Suppose a researcher proposes an alternative and shorter technique. The concurrent validity of the new technique would be established if there is a high correlation between the two techniques when administered at the same time under similar or identical conditions.

Predictive validity: This involves the ability of a measured phenomena at one point of time to predict another phenomenon at a future point of time. If the correlation coefficient between the two is high, the initial measure is said to have a high predictive ability. As an example, consider the use of the common admission test (CAT) to shortlist candidates for admission to the MBA programme in a business school. The CAT scores are supposed to predict the candidate's aptitude for studies towards business education.

3. Sensitivity

The sensitivity of a scale is an important measurement concept, particularly when changes in attitudes are under investigation. Sensitivity refers to an instrument's ability to accurately measure the variability in a concept. A dichotomous response category such as agree or disagree does not allow the recording of any attitude changes. A more sensitive measure with numerous categories on the scale may be required. For example, adding strongly agree, agree, neither agree nor disagree, disagree and strongly disagree categories will increase the sensitivity of the scale.

The sensitivity of scale based on a single question or a single item can be increased by adding questions or items. In other words, because composite measures allow for a greater range of possible scores, they are more sensitive than a single-item scale. Therefore, the sensitivity of the scale is generally increased by adding more response points or by adding scale items.

Check Your Progress

4. What is a pre-test?
5. How can the sensitivity of scale based on a single question or item be increased?

10.6 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

NOTES

1. The scaling techniques used in research can be classified into comparative and non-comparative scales.
2. There are four types of measurement scales—nominal, ordinal, interval and ratio scales.
3. Some examples of the ratio scale data are weight, distance travelled, income and sales of a company.
4. Pre-test is a trial test of a specific aspect of the study, such as the common methods of data collection or common data collection tools—schedule (used as tool for interviewing), questionnaire or measurement scale.
5. The sensitivity of scale based on a single question or a single item can be increased by adding questions or items.

10.7 SUMMARY

- In comparative scales it is assumed that respondents make use of a standard frame of reference before answering the question.
- Comparative scale data is interpreted generally in a relative kind. The comparative scale includes paired comparison, rank order, constant sum scale and Q-sort technique to mention a few.
- In the non-comparative scales, the respondents do not make use of any frame of reference before answering the questions. The resulting data is generally assumed to be interval or ratio scale.
- The non-comparative scales are divided into two categories, namely, the graphic rating scales and the itemized rating scales.
- In the graphic rating scale the respondent is asked to tick his preference on a graph.
- In the itemized rating scale, the respondents are provided with a scale that has a number of brief descriptions associated with each of the response categories.
- If an unbalanced scale is used, the nature and degree of the unbalance in the scale should be taken into account during the data analysis.
- The Stapel scale is used to measure the direction and intensity of an attitude. At times it, may be difficult to use semantic differential scales because of the problem in creating bipolar adjectives.
- There are four types of measurement scales—nominal, ordinal, interval and ratio scales. We will discuss each one of them in detail.

- The choice of the measurement scale has implications for the statistical technique to be used for data analysis.
- Pre-test is a trial test of a specific aspect of the study, such as the common methods of data collection or common data collection tools—schedule (used as tool for interviewing), questionnaire or measurement scale.
- Pre-test is the administration of the data collection instrument with a small set of respondents from the population for the full scale survey.
- The pre-testing of interview schedule involves contact with respondents drawn from the same population as for the actual survey.
- There are three criteria for good collection of data: reliability, validity and sensitivity.
- Reliability is concerned with consistency, accuracy and predictability of the scale. It refers to the extent to which a measurement process is free from random errors.
- The sensitivity of a scale is an important measurement concept, particularly when changes in attitudes are under investigation.

10.8 KEY WORDS

- **Focus Groups:** It refers to a group of people assembled to participate in a discussion about a product before it is launched, or to provide feedback on a political campaign, television series, etc.
- **Sensitivity:** It refers to an instrument's ability to accurately measure the variability in a concept.
- **Behaviour Coding:** It refers to a systematic coding of the interaction between interviewers and respondents from live or taped interviews.
- **Likert Scale:** It is a scale used to represent people's attitudes to a topic.
- **Split-Panel Tests:** They are the controlled experimental testing among questionnaire variants or interviewing modes for determining which is 'better' or for measuring differences between them.

10.9 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. What is graphic rating scale?
2. What should be kept in mind while designing itemized rating scale?
3. What is the staple scale used to measure?

4. Lists the steps involved in designing a questionnaire.
5. Discuss validity.

Long-Answer Questions

NOTES

1. What are comparative rating scales? Discuss its various types.
2. Describe the various non-comparative scales.
3. Examine the various types of measurement scales.
4. What is pre-test? Discuss its purpose.
5. Describe the methods of pre-testing a questionnaire.

10.10 FURTHER READINGS

Creswell, John W. 2002. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. London: Sage Publications Inc.

Booth, Wayne, Gregory G. Colomb and Joseph M. Williams. 1995. *The Craft of Research*. Chicago: University of Chicago Press.

Bryman, Alan and Emma Bell. 2015. *Business Research Methods.* 4th Edition. United Kingdom: Oxford University Press.

Gupta, S.L. and Hitesh Gupta. 2012. *Business Research Methods.* New Delhi: Tata McGraw Hill Education Private Limited.

UNIT 11 PROCESSING AND ANALYSIS OF DATA

Structure

11.0 Introduction
11.1 Objectives
11.2 Meaning, Importance and Process of Data Analysis: Editing, Coding, Tabulation and Diagrams
11.3 Types of Analysis
11.4 Answers to Check Your Progress Questions
11.5 Summary
11.6 Key Words
11.7 Self Assessment Questions and Exercises
11.8 Further Readings

11.0 INTRODUCTION

In the previous unit, you learnt about scaling techniques and pre-testing of data collection tools. In this unit, we will begin our discussion on the processing and analysis of data. The process of inspecting, cleaning, transforming and modelling data with the specific purpose of highlighting useful information, suggesting conclusions and supporting decision making is termed as analysis of data. There are multiple facets and approaches to data analysis. The data that is acquired must be identified as a matter of utmost importance. This is followed by the processing and analysis of the same in order to infer proper and accurate results. This unit focuses on the meaning, importance and the process of data analysis.

11.1 OBJECTIVES

After going through this unit, you will be able to:

- Discuss the meaning and importance of data analysis
- Explain the process of data analysis
- Examine the importance and significance of coding
- Classify data according to the various class intervals

11.2 MEANING, IMPORTANCE AND PROCESS OF DATA ANALYSIS: EDITING, CODING, TABULATION AND DIAGRAMS

Research does not merely consist of data that is collected. Research is incomplete without proper analysis of the collected data. Processing of data

involves analysis and manipulation of the collected data by performing various functions. The data has to be processed in accordance with the outline laid down at the time of developing the research plan. Processing of data is essential for ensuring that all relevant data has been collected to perform comparisons and analyses. The functions that can be performed on data are as follows:

- Editing
- Coding
- Tabulation
- Classification

Usually, experts are of the opinion that the exercise of processing and analysing of data is inter-related. Therefore, the two should be thought as one and the same thing. It is argued that analysis of data generally involves a number of closely-related operations, which are carried out with the objective of summarizing the collected data and organizing it in such a way that they are able to answer the research questions associated with it.

However, in technical terms, processing of data involves data representation in a way that it is open to analysis. Similarly, analysis of data is defined as the computation of certain measures along with searching for the patterns of relationship that may exist among data groups.

Editing of data

Editing of data involves the testing of data collection instruments in order to ensure maximum accuracy. This includes checking the legibility, consistency and completeness of the data. The editing process aims at avoiding equivocation and ambiguity. The collected raw data is also examined to detect errors and omissions, if any. A careful scrutiny is performed on the completed questionnaires and schedules to assure that the data has the following features:

- Accuracy
- Consistency
- Unity
- Uniformity
- Effective arrangement

The stages at which editing should be performed can be classified as follows:

- **Field editing**: This involves reviewing the reporting forms, by the investigator, that are written in an abbreviated or illegible form by the informant at the time of recording the respondent's responses. Such type of editing must be done immediately after the interview. If performed after some time, such editing becomes complicated for the researcher,

as it is difficult to decipher any particular individual's writing style. The investigator needs to be careful while field editing and restrain the researcher from correcting errors or omission by guesswork.

- **Central editing**: This kind of editing involves a thorough editing of the entire data by a single editor or a team of editors. It takes place when all the schedules created according to the research plan have been completed and returned to the researcher. Editors correct the errors such as data recorded in the wrong place or the data recorded in months when it should be recorded in weeks. They can provide an appropriate answer to incorrect or missing replies by reviewing the other information in the schedule. At times, the respondent can be contacted for clarification. In some cases, if the answer is inappropriate or incomplete and an accurate answer cannot be determined on any basis, then the editor should delete or remove that answer from the collected data. He/She can put a note as 'no answer' in this case. The answers that can be easily deciphered as wrong should be dropped from the final results.

Besides using the above-stated methods according to the data source, the researcher should also keep in mind the following points while editing:

- Familiarity with the instructions given to interviewers and coders
- Know-how of editing instructions
- Single line striking for deleting of an original entry
- Standardized and distinctive editing of data
- Initialization of all answers that are changed

Coding of data

The coding of data can be defined as representing the data symbolically using some predefined rules. Once data is coded and summarized, the researcher can analyse it and relationships can be found among its various categories.

Checklist for coding

This enables the researcher to classify the responses of the individuals according to a limited number of categories or classes. Such classes should possess the following important characteristics:

- Classes should be appropriate and in accordance to the research problem under consideration.
- They must include a class for every data element.
- There should be a mutual exclusivity, which means that a specific answer can be placed in one and only one cell of a given category set.
- The classes should be one-dimensional. This means that every class is defined in terms of only one concept.

NOTES

Significance of coding

Coding of data is necessary for its efficient analysis. Codiing facilitates reduction of data from a variety to a small number of classes. Thus, only that information which is important and critical for analysis is retained in the research. Coding decisions are usually taken at the designing stage of the questionnaire. This makes it possible to pre-code the questionnaire choices, which in turn, is helpful for computer tabulation.

However, in case of hand coding, some standard method should be used. One such method is to code in the margin with a coloured pencil. The other method is to transcribe data from the questionnaire to a coding sheet. Whatever method is adopted, you should ensure that coding errors are altogether eliminated or reduced to a minimum level.

Classification of data

Research studies involve extensive collection of raw data and usage of the data to implement the research plan. To make the research plan easier, the data needs to be classified in different groups for understanding the relationship among the different phases of the research plan. Classification of data involves arrangement of data in groups or classes on the basis of some common characteristics. The methods of classification can be divided under the following two headings:

- Classification according to attributes
- Classification according to class intervals

Figure 11.1 shows the categories of data.

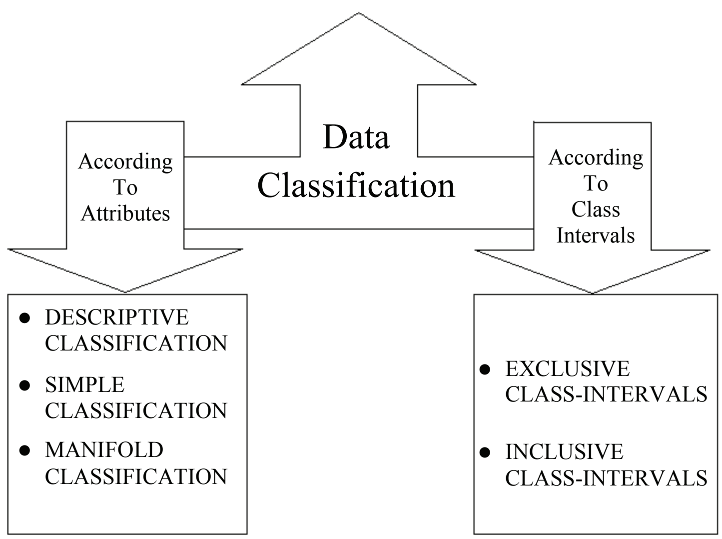


Fig. 11.1 *Data Classification*

Classification of data according to attributes

Data is classified on the basis of similar features as follows:

- **Descriptive classification:** This classification is performed according to the qualitative features and attributes which cannot be measured quantitatively. These features can be either present or absent in an individual or an element. The features related to descriptive classification of attributes can be literacy, sex, honesty, solidarity, etc.
- **Simple classification:** In this classification the elements of data are categorized on the basis of those that possess the concerned attribute and those that do not.
- **Manifold classification:** In this classification two or more attributes are considered simultaneously and the data is categorized into a number of classes on the basis of those attributes. The total number of classes of final order is given by 2^n, where n = number of attributes considered.

Classification of data according to class intervals

Classifying data according to the class intervals is a quantitative phenomenon. Class intervals help categorize the data with similar numerical characteristics, such as income, production, age, weight, etc. Data can be measured through some statistical tools like mean, mode, median, etc. The different categories of data according to class intervals are as follows:

- **Statistics of variables:** This term refers to the measurable attributes, as these typically vary over time or between individuals. The variables can be discrete, i.e., taking values from a countable or finite set, continuous, i.e., having a continuous distribution function, or neither. This concept of variable is widely utilized in the social, natural and medical sciences.
- **Class intervals:** They refer to a range of values of a variable. This interval is used to break up the scale of the variable in order to tabulate the frequency distribution of a sample. A suitable example of such data classification can be given by means of categorizing the birth rate of a country. In this case, babies aged zero to one year will form a group; those aged two to five years will form another group, and so on. The entire data is thus categorized into several numbers of groups or classes or in other words, class intervals. Each class interval has an upper limit as well as a lower limit, which is defined as 'the class limit.' The difference between two class limits is known as class magnitude. Classes can have equal or unequal class magnitudes.

The number of elements, which come under a given class, is called the frequency of the given class interval. All class intervals, with their respective frequencies, are taken together and described in a tabular form called the frequency distribution.

NOTES

Problems related to classification of data

The problems related to classification of data on the basis of class intervals are divided into the following three categories:

(*i*) **Number of classes and their magnitude:** There are differences regarding the number of classes into which data can be classified. As such, there are no pre-defined rules for the classification of data. It all depends upon the skill and experience of the researcher. The researcher should display the data in such a way that it should be clear and meaningful to the analyst.

As regards the magnitude of classes, it is usually held that class intervals should be of equal magnitude, but in some cases unequal magnitudes may result in a better classification. It is the researcher's objective and judgement that plays a significant role in this regard. In general, multiples of two, five and ten are preferred while determining class magnitudes. H.A. Sturges suggested the following formula to determine the size of class interval:

where,

i = size of class interval

R = Range (difference between the values of the largest element and smallest element among the given elements)

N = Number of items to be grouped

Sometimes, data may contain one or two or very few elements with very high or very low values. In such cases, the researcher can use an open-ended interval in the overall frequency distribution. Such intervals can be expressed below two years; or twelve years and above. However, such intervals are not desirable, yet cannot be avoided.

(*ii*) **Choice of class limits:** While choosing class limits, the researcher must determine the mid-point of a class interval. A mid-point is, generally, derived by taking the sum of the upper and lower limit of a class and then dividing it by two. The actual average of elements of that class interval should remain as close to each other as possible. In accordance with this principle, the class limits should be located at multiples of two, five, ten, twenty and hundred and such other figures. The class limits can generally be stated in any of the following forms:

o **Exclusive type class intervals**: These intervals are usually stated as follows:

- 10–20
- 20–30
- 30–40
- 40–50

These intervals should be read in the following way:

- 10 and under 20
- 20 and under 30
- 30 and under 40
- 40 and under 50

In the exclusive type of class intervals, the elements whose values are equal to the upper limit of a class are grouped in the next higher class. For example, an item whose value is exactly thirty would be put in 30–40-class interval and not in 20–30-class interval. In other words, an exclusive type of class interval is that in which the upper limit of a class interval is excluded and items with values less than the upper limit, but not less than the lower limit, are put in the given class interval.

o **Inclusive type class intervals**: These intervals are normally stated as follows:

- 11–20
- 21–30
- 31–40
- 41–50

This should be read as follows:

- 11 and under 21
- 21 and under 31
- 31 and under 41
- 41 and under 51

In this method, the upper limit of a class interval is also included in the concerning class interval. Thus, an element whose value is twenty will be put in 11–20-class interval. The stated upper limit of the class interval 11–20 is twenty but the real upper limit is 20.999999 and as such 11–20 class interval really means eleven and under twenty-one. When data to be classified happens to be a discrete one, then the inclusive type of classification should be applied. But when data happens to be a continuous one, the exclusive type of class intervals can be used.

(*iii*) **Determining the frequency of each class**: The frequency of each class can be determined using tally sheets or mechanical aids. In tally sheets, the class groups are written on a sheet of paper and for each item a stroke (a small vertical line) is marked against the class group in which it falls. The general practice is that after every four small vertical lines in a class group, the fifth line for the element falling in the same group is indicated as a diagonal line through the above said four lines. This

NOTES

enables the researcher to perform the counting of elements in each one of the class groups. Table 11.1 displays a hypothetical tally sheet.

Table 11.1 *A Tally Sheet*

Income groups (Rupees)	Tally mark	Number of families (Class frequency)
Below 600	~~IIII~~ ~~IIII~~ ~~IIII~~ III	8
601-900	~~IIII~~ ~~IIII~~ I	11
901-1300	~~IIII~~ ~~IIII~~ ~~IIII~~ ~~IIII~~ ~~IIII~~ ~~IIII~~ I	31
1301-1500	~~IIII~~ ~~IIII~~ ~~IIII~~ IIII	19
1501 and above	~~IIII~~ ~~IIII~~ II	12
Total		91

In case of large inquiries and surveys, class frequencies can be determined by means of mechanical aids, i.e., with the help of machines. Such machines function, either manually or automatically and run on electricity. These machines can sort out cards at a speed of around 25,000 cards per hour. Although this method increases the speed, it is an expensive method.

Tabulation of data

In simple terms, tabulation means placing the results and data collected from research in a tabular form.

Methods of tabulation

Tabulation can be done either manually or mechanically using various electronic devices. Several factors like the size and type of study, cost considerations, time pressures and availability of tabulating machines decide the choice of tabulation. Relatively large data requires computer tabulation. Manual tabulation is preferred in case of small inquiries, when the number of questionnaires is small and they are of relatively short length. The different methods used in hand tabulation are as follows:

- **Direct tally method**: This method involves simple codes, which the researcher can use to directly tally data with the questionnaire. The codes are written on a sheet of paper called tally sheet and for each response, a stroke is marked against the code in which it falls. Usually, after every four strokes against a particular code, the fifth response is indicated by drawing a diagonal or horizontal line through the strokes. These groups are easy to count and the data is sorted against each code conveniently.
- **List and tally method**: In this method, code responses may be transcribed into a large worksheet, allowing a line for each questionnaire. This facilitates listing of a large number of questionnaires in one worksheet. Tallies are then made for each question.

- **Card sort method**: This is the most flexible hand tabulation method, where the data is recorded on special cards that are of convenient sizes and shapes and have a series of holes. Each hole in the card stands for a code. When the cards are stacked, a needle passes through a particular hole representing a particular code. These cards are then separated and counted. In this way, frequencies of various codes can be found out by the repetition of this technique.

Significance of tabulation

Tabulation enables the researcher to arrange data in a concise and logical order. It summarizes the raw data and displays the same in a compact form for further analysis. It helps in the orderly arrangement of data in rows and columns. The various advantages of tabulation of data are as follows:

- A table saves space and reduces descriptive and explanatory statements to the minimum.
- It facilitates and eases the comparison process.
- Summation of elements and detection of omissions and errors becomes easy in a tabular description.
- A table provides a basis for various statistical computations.

Checklist for tables

A table should communicate the required information to the reader in such a way that it becomes easy for him/her to read, comprehend and recall information when required. Certain conventions have to be followed during tabulation of data. These are as follows:

- All tables should have a clear, precise and adequate title to make them intelligible enough without any reference to the text.
- Tables should be featured with clarity and readability.
- Every table should be given a distinct number to facilitate an easy reference.
- The table should be of an appropriate size and tally with the required information.
- Headings for columns and rows should be in bold font letters. It is a general rule to include an independent variable in the left column or the first row. The dependent variable is contained in the bottom row or the right column.
- Numbers should be displayed such that they are neat and readable.
- Explanatory footnotes, if any, regarding the table should be placed directly beneath the table, along with the reference symbols used in the table.

- The source of the table should be indicated just below the table.
- The table should contain thick lines to separate data under one class from the data under another class and thin lines to separate the different subdivisions of the classes.
- All column figures should be properly aligned.
- Abbreviations should be avoided in a table to the best possible extent.
- If data happens to be large, then it should not be crowded in a single table. It makes the table unwieldy and inconvenient.

Tabulation can also be classified as complex and simple. The former type of tabulation gives information about one or more groups of independent variables, whereas, the latter shows the division of data in two or more categories.

Diagrams

The data we collect can often be more easily understood for interpretation if it is presented graphically or pictorially. Diagrams and graphs give visual indications of magnitudes, groupings, trends and patterns in the data. These important features are more simply presented in the form of graphs. Also, diagrams facilitate comparisons between two or more sets of data.

The diagrams should be clear and easy to read and understand. Too much information should not be shown in the same diagram; otherwise, it may become cumbersome and confusing. Each diagram should include a brief and self-explanatory title dealing with the subject matter. The scale of the presentation should be chosen in such a way that the resulting diagram is of appropriate size. The intervals on the vertical as well as the horizontal axis should be of equal size; otherwise, distortions would occur.

Diagrams are more suitable to illustrate the data which is discrete, while continuous data is better represented by graphs. We will study about diagrammatic elucidation in detail in the next unit.

11.3 TYPES OF ANALYSIS

Analysis of data is the process of transforming data for the purpose of extracting useful information, which in turn facilitates the discovery of some useful conclusions. Finding conclusions from the analysed data is known as interpretation of data. However, if the analysis is done, in the case of experimental data or survey, then the value of the unknown parameters of the population and hypothesis testing is estimated.

Analysis of data can be either descriptive or inferential. Inferential analysis is also known as statistical analysis. The descriptive analysis is used to describe the basic features of the data in a study such as persons, work

groups and organizations. The inferential analysis is used to make inferences from the data, which means that we are trying to understand some process and make some possible predictions based on this understanding.

NOTES

The three types of analyses are as follows:

(i) **Multiple regression analysis:** This type of analysis is used to predict a single dependent variable by a set of independent variables. In multiple regression analysis, the independent variables are not correlated to each other.

(ii) **Multiple discriminant analysis:** In multiple discriminant analysis, there is one single dependent variable, which is very difficult to measure. One of the main objectives of this type of analysis is to understand the group differences and predict the likelihood that an entity, i.e., an individual or an object, belongs to a particular class or group based on several metric-independent variables.

(iii) **Canonical correlation analysis:** It is a method for assessing the relationship between variables. This analysis also allows you to investigate the relationship between two sets of variables.

Univariate, Bivariate and Multivariate Analysis

Many types of analyses are performed according to the variance that exists in the data. Such analyses is carried out to check if the differences between three or more variables are significant enough to evaluate them statistically. There are three types of such analyses; namely, univariate, bivariate and multivariate analyses. These types are explained below:

(i) **Univariate analysis**: In this analysis, only a single variable is taken into consideration. It is usually the first activity pursued while analysing the data. It is performed with the purpose of describing each variable in terms of mean, median or mode, and variability. Examples of such analysis are averages or a set of cases that may come under a specific category amidst a whole sample.

(ii) **Bivariate analysis**: This type of examines the relationship between two variables. It tries to find the extent of association that exists among these variables. Thus, a bivariate analysis may help you; for example, to find whether the variables of irregular meals and migraine headaches are associate; and up to what extent. Here, two variables are thus statistically measured simultaneously.

(iii) **Multivariate analysis**: This type of analysis involves observation and analysis of three or more than three statistical variables at a time. Such an analysis is performed using statistical tests or even in a tabular format. Thus, for example, you can study the variables of age, educational qualification and annual income of a given set of population at the same time using the multivariate analysis method.

Usually, these types of analyses are more convenient when performed in a tabular format. This involves, using a cross-classification or contingency table. Such a table is made of two columns and two rows, showing the frequencies of two variables that are displayed in rows and columns. This is more popularly known as constructing the bivariate table. Traditionally, the independent variable is displayed in columns and the dependent ones in rows. A multivariate table, if related to the same data, is the result of combining the bivariate tables. In this case, each bivariate table is known as partial table. Usually, a multivariate table is created with the purpose of explaining or replicating the primary relationship that is found in the bivariate table. Table 11.2(a) and (b) shows an example of a bivariate table and a multivariate table.

Table 11.2 (a) *Bivariate Table*

	1991	**1992**	**1993**
Percentage of students failed	33 per cent	38 per cent	42 per cent
Percentage of students passed	67 per cent	62 per cent	58 per cent

Table 11.2 (b) *Multivariate Table*

	1991	**1992**	**1993**
	First Attempt	Second Attempt	Third Attempt
Percentage of students who passed in Maths	27 per cent	35 per cent	–
Percentage of students who passed in English	53 per cent	60 per cent	44 per cent

Although the data in both tables is related, except the variable of 'attempts', the multivariate table has been displayed separately in this example. However, you should note that the tables have dealt simultaneously with two or more variables of the data.

Data interpretation

Data interpretation refers to the identification of trends in different variables. The researcher uses statistics for this purpose. The researcher is required to be familiar with the knowledge of the scales of measurement. This enables him/her to choose the appropriate statistical method for his/her research project. The scales of measurement facilitate the allotment of numerical values to characteristics adhering to any specific rules. This measurement is also related to such levels of measurement of data like nominal, ordinal and internal and ratio levels. These levels can be explained as follows:

- **Nominal measurement**: The nominal measurement assigns a numeral value to a specific characteristic. It is the fundamental form of measurement. The nominal measurement calculates the lowest level of data available for measurement.
- **Ordinal measurement**: This type of measurement involves allotting a specific feature to numeral value in terms of a specific order. The ordinal scale displays the way in which the entity is measured. The ordinal scale of measurement is used to calculate and derive data pertaining to the median, percentage, rank order, correlations and percentile.
- **Interval measurement**: A researcher can depict the difference between the first aspect of a data and another aspect using this level of measurement. The interval scale of measurement is useful for the researcher in several ways. It can be applied in the calculation of arithmetic mean, averages, standard deviations and determining correlation between different variables.
- **Ratio measurement**: In this method, there are fixed proportions (ratio) between the number numerical and the amount of the characteristics that it represents. A researcher should remember while measuring the ratio levels that, a fixed zero point exists. The ratio level of measurement facilitates researchers in determining, if the aspects possess any certain characteristic. Almost any type of arithmetical calculations can be executed using this scale of measurement.

The most important feature of any measuring scale is its reliability and validity, which is explained as follows:

- **Reliability**: It is the term used to deal with accuracy. A scale measurement can be said to be reliable, when it exactly measures, only that what it is supposed to measure. In other words, when the same researcher repeats a test, i.e., with a different group but resembling the original group, he/she should get the same results as the former.
- **Validity**: According to Leedy, validity is the assessment of the soundness and the effectiveness of the measuring instrument. There are four types of validity, which can be stated as follows:
  - o **Content validity**: It deals with the accuracy with which an instrument measures the factors or content of the course or situations of the research study.
  - o **Prognostic validity**: It depends on the possibility to make judgements from results obtained by the concerned measuring instrument. The judgement is future oriented.
  - o **Simultaneous validity**: This involves comparing of one measuring instrument with another; one that measures the same characteristic and is available immediately.

Multiple regression analysis

Multiple regression analysis is a statistical tool that helps the researchers to evaluate the effect of different factors on the consequences occurring at the same time. It analyzes the relationship between several independent or predictor variables and a dependent variable. In research technology, regression analysis is used to investigate a particular set of predictors and to show differences in the consequences that occur. Generally, regression is used to determine the effect of the specific factors along with the other factors that influence these consequences. The researchers use algebraic methods to analyze the result by making a group of factors associated with a particular phenomenon as a constant. According to the dictionary meaning, the multiple regression is a statistical technique that predicts values of one variable on the basis of two or more other variables.

Multiple regression and statistics: The term 'multiple regression' was first given by Pearson. The regression is of two types, simple and multiple and both the regression techniques are related to the Analysis Of Variance (ANOVA). Of these, multiple regression is the simplest method in comparison to other multivariate statistical techniques.

Multiple regression and mathematics: The multiple regression technique is used in mathematics to formulate simple regression equations, and to evaluate the best fitting curve for a straight line along the dots on an *x-y* plot or a scattergram.

Check Your Progress

1. What do you mean by processing of data?
2. List the functions that can be performed on data.
3. What is 'field editing'?
4. Data can be classified into three categories. What are they?
5. List three types of analyses.

11.4 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. Research is incomplete without proper analysis of the collected data. Processing of data involves analysis and manipulation of the collected data by performing various functions.
2. The functions that can be performed on data are:
   - Editing
   - Coding

- Tabulation
- Classification

3. The method of field editing involves reviewing reporting forms by the investigator that are written in an abbreviated form by the informant. This kind of editing is usually done immediately after the interview.
4. Data can be classified into three categories, they are, descriptive classification, simple classification and manifold classification.
5. Three types of analysis are:
   - Multiple regression analysis
   - Multiple discriminant analysis
   - Canonical correlation analysis

11.5 SUMMARY

- Research does not merely consist of data that is collected. Research is incomplete without proper analysis of the collected data.
- Data processing involves analysis and manipulation of the collected data by performing various functions. The data has to be processed in accordance with the outline laid down when the research plan in being developed.
- Editing of data involves the testing of data collection instruments in order to ensure maximum accuracy.
- A collected data must have five features, such as accuracy, consistency, unity, uniformity and effective arrangement.
- Representing the data symbolically by using some predefined rules is termed as coding of data. Coding of data is very much essential for performing efficient analysis.
- Data can be classified into three categories according to attributes and into two as per class intervals.
- Tabulation means placing the results and data collected from research in a tabular form. Tabulation can be done either mechanically or manually using various electronic devices.
- The process of tabulation enables the researcher to arrange data in a concise and logical order. It summarizes raw data and displays the same in a compact form for further analysis.
- Analysis of data is the process of transforming data for the purpose of extracting useful information, which in turn facilitates the discovery of some useful conclusions.

NOTES

- Analysis of data can be either descriptive or inferential. Inferential analysis is also known as statistical analysis.
- The descriptive analysis is used to describe the basic features of the data in a study such as persons, work groups and organizations.
- The inferential analysis is used to make inferences from the data, which means that we are trying to understand some process and make some possible predictions based on this understanding.
- Many types of analyses are performed according to the variance that exists in the data. Such analyses is carried out to check if the differences between three or more variables are significant enough to evaluate them statistically.
- Data interpretation refers to the identification of trends in different variables. The researcher uses statistics for this purpose.
- Multiple regression analysis is a statistical tool that helps the researchers to evaluate the effect of different factors on the consequences occurring at the same time.
- Multiple regression analyses the relationship between several independent or predictor variables and a dependent variable.

11.6 KEY WORDS

- **Coding of Data:** It refers to a symbolic representation of date using some predefined rules.
- **Analysis of Data:** It refers to the process of transforming data for the purpose of extracting useful information.
- **Multiple Regression Analysis:** It is a statistical tool that helps the researchers to evaluate the effect of different factors on the consequences occurring at the same time.

11.7 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. What is processing and data analysis?
2. What is central editing?
3. Briefly discuss the significance of coding.
4. Write a short note on the classification of data according to attributes.

Long-Answer Questions

1. Examine the classification of data.
2. What are the problems related to classification of data? Discuss.
3. Define tabulation and explain its methods. What is its significance?

11.8 FURTHER READINGS

Creswell, John W. 2002. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. London: Sage Publications Inc.

Booth, Wayne, Gregory G. Colomb and Joseph M. Williams. 1995. *The Craft of Research*. Chicago: University of Chicago Press.

Bryman, Alan and Emma Bell. 2015. *Business Research Methods.* 4th Edition. United Kingdom: Oxford University Press.

Gupta, S.L. and Hitesh Gupta. 2012. *Business Research Methods.* New Delhi: Tata McGraw Hill Education Private Limited.

NOTES

BLOCK - IV

HYPOTHESIS AND REPORT WRITING

UNIT 12 TEST OF HYPOTHESIS

Structure

12.0 Introduction
12.1 Objectives
12.2 Fundamentals of Test Procedure
  12.2.1 Types of Hypothesis Testing
12.3 Parametric Tests
  12.3.1 Tests Concerning Means in Case of Single and Two Population Means-Z-test
  12.3.2 Hypothesis Testing for Comparing Two Related Terms: T-test
  12.3.3 Hypothesis Testing of Proportions, Difference between Proportions and Comparing Variance
  12.3.4 Testing the Equality of Variances of Two Normal Populations: F-test
12.4 Statistical Techniques of Hypothesis Testing
12.5 Chi-Square Test and Contingency Table
12.6 Answers to Check Your Progress Questions
12.7 Summary
12.8 Key Words
12.9 Self Assessment Questions and Exercises
12.10 Further Readings

12.0 INTRODUCTION

In the previous unit, you were introduced to the processing and analysis of data. In this unit, the discussion on the analysis and processing of data will continue. It will discuss various parametric tests such as T test, F test and Z test. The unit will begin with a discussion on the fundamentals of testing procedure, as well as the various types of hypothesis testing.

12.1 OBJECTIVES

After going through this unit, you will be able to:

- Discuss the fundamentals of hypothesis testing procedure
- Examine the various types of parametric tests
- Illustrate the chi-square test, t-test and z-test

12.2 FUNDAMENTALS OF TEST PROCEDURE

The following fundamental steps are followed in testing of a hypothesis:

Setting up of a hypothesis: First step is to establish the hypothesis to be tested. As it is known, these statistical hypotheses are generally assumptions about the value of the population parameter; the hypothesis specifies a single value or a range of values for two different hypotheses rather than constructing a single hypothesis. These two hypotheses are generally referred to as the (1) null hypotheses denoted by H_0 and (2) alternative hypothesis denoted by H_1.

The null hypothesis is the hypothesis of the population parameter taking a specified value. In case of two populations, the null hypothesis is of no difference or the difference taking a specified value. The hypothesis that is different from the null hypothesis is the alternative hypothesis. If the null hypothesis H_0 is rejected based upon the sample information, the alternative hypothesis H_1 is accepted. Therefore, the two hypotheses are constructed in such a way that if one is true, the other one is false and vice versa. There can also be situations where the researcher is interested in establishing the relationship between any two variables. In such a case, a null hypothesis is set as the hypothesis of no relationship between those two variables; whereas the alternative hypothesis is the hypothesis of the relationship between variables. The rejection of the null hypothesis indicates that the differences/relationship have a statistical significance and the acceptance of the null hypothesis means that any difference/relationship is due to chance.

Setting up of a suitable significance level: The next step in the testing of hypothesis exercise is to choose a suitable level of significance. The level of significance denoted by α is chosen before drawing any sample. The level of significance denotes the probability of rejecting the null hypothesis when it is true. The value of α varies from problem to problem, but usually it is taken as either 5 per cent or 1 per cent. A 5 per cent level of significance means that there are 5 chances out of hundred that a null hypothesis will get rejected when it should be accepted. This means that the researcher is 95 per cent confident that a right decision has been taken. Therefore, it is seen that the confidence with which a researcher rejects or accepts a null hypothesis depends upon the level of significance. When the null hypothesis is rejected at any level of significance, the test result is said to be significant. Further, if a hypothesis is rejected at 1 per cent level, it must also be rejected at 5 per cent significance level.

Determination of a test statistic: The next step is to determine a suitable test statistic and its distribution. As would be seen later, the test statistic could be t, Z, χ^2 or F, depending upon various assumptions to be discussed later in the book.

Determination of critical region: Before a sample is drawn from the population, it is very important to specify the values of test statistic that will lead to rejection or acceptance of the null hypothesis. The one that leads to the rejection of null hypothesis is called the critical region. Given a level of significance, α, the optimal critical region for a two-tailed test consists of that α/2 per cent area in the right hand tail of the distribution plus that α/2 per cent in the left hand tail of the distribution where that null hypothesis is rejected. Therefore, establishing a critical region is similar to determining a 100 (1 – α) per cent confidence interval.

Computing the value of test-statistic: The next step is to compute the value of the test statistic based upon a random sample of size n. Once the value of test statistic is computed, one needs to examine whether the sample results fall in the critical region or in the acceptance region.

Making decision: The hypothesis may be rejected or accepted depending upon whether the value of the test statistic falls in the rejection or the acceptance region. Management decisions are based upon the statistical decision of either rejecting or accepting the null hypothesis.

If the hypothesis is being tested at 5 per cent level of significance, it would be rejected if the observed results have a probability less than 5 per cent. In such a case, the difference between the sample statistic and the hypothesized population parameter is considered to be significant. On the other hand, if the hypothesis is accepted, the difference between the sample statistic and the hypothesized population parameter is not regarded as significant and can be attributed to chance.

12.2.1 Types of Hypothesis Testing

A hypothesis is tested to identify the errors that have occurred in the statements and concepts used in that hypothesis. Hypothesis testing can be broadly divided into two types, which are as follows:

- Parametric tests or standard tests of hypothesis
- Non-parametric tests or distribution-free tests of hypothesis

There are the two general classes of statistical tests. Parametric tests are more powerful because their data is either of interval or ratio level and based on the following assumptions:

(a) The observations must be independent.

(b) The observations need to be drawn from populations that are normally distributed.

(c) The populations should have equal variances.

It is the researcher's responsibility to check the assumptions relevant to the chosen test. Some of the popular parametric tests are z-test t-test and F-test.

Non-parametric tests, on the other hand, have less stringent and fewer assumptions. They do not specify normally distributed populations or equality of variances. Some tests require independence of cases, while others are designed expressly for situations with related cases. Non-parametric tests are generally used for qualitative analysis (ordinal or nominal-level data). Both the categories of tests provide efficient results provided their selections are appropriate. Non-parametric tests include chi-square, run-test, Mann-Whitney test, Kruskal-Wallis test, etc.

1. *Parametric tests or standard tests of hypothesis*

Parametric tests assume certain properties of the population sample such as observations from a normal population, large sample size, population parameters like mean and variance. The various parametric tests of hypothesis are based on the assumption of normality. In other words, the source of data for them is normally distributed. They can be listed as follows:

- **Z-test**: This kind of test is based on normal probability distribution. It is mostly used to judge the significance of mean as a statistical measure. This is the most frequently used test in research studies. It is generally used to compare the mean of a sample with the hypothesized mean of the population. It is also used in case the population variance is known. It is helpful in judging the significance of difference between the means of two independent large samples, to compare the sample proportion to a theoretical value of population proportion and to judge the significance of median, mode and coefficient of correlation.
- **T-test**: This test is based on t-distribution and is used to judge the significance of a sample mean or the difference between the means of two small samples when the population variance is not known.
- χ^2: This test is based on a chi-square distribution and is used for comparing a sample variance to a theoretical population variance.
- **F-test**: This test is based on F-distribution and is also used to compare the variance of two independent samples. It is also used to compare the significance of multiple correlation coefficients.

2. *Non-parametric tests or distribution-free tests of hypothesis*

There are situations in testing where assumptions cannot be made. In such situations, non-parametric methods are employed. There are various types of non-parametric tests. The important ones are as follows:

- **Sign test**: This is one of the easiest tests in practice based on the plus/minus sign of an observation in a sample. The sign may be one of the following two types:
  - o **One-sample sign test**: This is a very simple distribution-free test and is applied in case of a sample from a continuous symmetrical

NOTES

population, wherein the probability of a sample to be either less or more than mean is half. Here, to test a null hypothesis, all those items, which are greater than the alternate hypothesis, are replaced by a plus sign and those, which are less than the alternate hypothesis, are replaced by a minus sign.

- o **Two-sample sign test**: In case of all the problems consisting of paired data, two-sample sign test is used. Here, each pair of values can be replaced with a plus sign in the first value of the first sample with the first value of the second sample. If the first value is less, minus sign is assigned.

- **Fisher–Irwin test**: This is applied where there is no difference between two sets of data. In other words, it is used where you can assume that two different treatments are supposedly different in terms of the results that they produce. It is applied in all those cases where result for each item in a sample can be divided into one of the two mutually exclusive categories.
- **McNamara test**: It is applied where the data is nominal in nature and is related to two interrelated samples. By using this test, you can judge the significance of any observed changes in the same subject.
- **Wilcoxon matched-pairs test**: This test is applied in the case of a matched-pair such as output of two similar machines. Here, you can determine both the direction and the magnitude between the matched values. This test is also called Signed Rank Test.

Check Your Progress

1. What are the two types of hypothesis testing?
2. When is the Fisher-Irwin test applied?

12.3 PARAMETRIC TESTS

A parametric statistical test is one that makes assumptions about the parameters (defining properties) of the population distribution(s) from which one's data are drawn. Let us study these tests in detail.

12.3.1 Tests Concerning Means in Case of Single and Two Population Means- Z-test

In case the sample size n is large or small but the value of the population standard deviation is known, a Z-test is appropriate. There can be alternate cases of two- tailed and one-tailed tests of hypotheses. Corresponding to the null hypothesis $H_0 : \mu = \mu_0$, the following criteria could be used as shown in Table 12.1.

The test statistic is given by,

$$Z = \frac{\bar{X} - \mu_{H_0}}{\frac{\sigma}{\sqrt{n}}}$$

NOTES

where,

$\bar{X}$ = Sample mean

σ = Population standard deviation

μ_{H0} = The value of μ under the assumption that the null hypothesis is true

n = Size of sample

Table 12.1 *Criteria for accepting or rejecting null hypothesis under different cases of alternative hypotheses*

S. No.	Alternative Hypothesis	Reject the Null Hypothesis if	Accept the Null Hypothesis if
1.	$\mu < \mu_0$	$Z < -Z_\alpha$	$Z \geq -Z_\alpha$
2.	$\mu > \mu_0$	$Z > Z_\alpha$	$Z \leq Z_\alpha$
3.	$\mu \neq \mu_0$	$Z < -Z_{\alpha/2}$ Or $Z > Z_{\alpha/2}$	$-Z_{\alpha/2} \leq Z \leq Z_{\alpha/2}$

If the population standard deviation σ is unknown, the sample standard deviation

$$s = \sqrt{\frac{1}{n-1}\Sigma(X - \bar{X})^2}$$

is used as an estimate of σ. It may be noted that Z_α and $Z_{\alpha/2}$ are Z values such that the area to the right under the standard normal distribution is α and $\alpha/2$ respectively. Below are solved examples using the above concepts.

Example 12.1

A sample of 200 bulbs made by a company give a lifetime mean of 1540 hours with a standard deviation of 42 hours. Is it likely that the sample has been drawn from a population with a mean lifetime of 1500 hours? You may use 5 per cent level of significance.

Solution:

In the above example, the sample size is large (n = 200), sample mean ($\bar{X}$) equals 1540 hours and the sample standard deviation (s) is equal to 42 hours. The null and alternative hypotheses can be written as:

H_0 : μ = 1500 hrs

H_1 : $\mu \neq$ 1500 hrs

NOTES

It is a two-tailed test with level of significance (α) to be equal to 0.05. Since n is large (n > 30), though population standard deviation σ is unknown, one can use Z-test. The test statistics are given by:

$$Z = \frac{\overline{X} - \mu_{H_0}}{\sigma_{\overline{X}}}$$

where, μ_{H0} = Value of μ under the assumption that the null hypothesis is true

$\hat{\sigma}_{\overline{X}}$ = Estimated standard error of mean

Here, $\mu_{H_0} = 1500,\ \hat{\sigma}_{\overline{X}} = \frac{\hat{\sigma}}{\sqrt{n}} = \frac{s}{\sqrt{n}} = \frac{42}{\sqrt{200}} = 2.97$

(Note $\hat{\sigma}$ that is estimated value of σ.)

$$Z = \frac{\overline{X} - \mu_{H_0}}{\frac{s}{\sqrt{n}}} = \frac{1540 - 1500}{2.97} = \frac{40}{2.97} = 13.47$$

The value of α = 0.05 and since it is a two-tailed test, the critical value Z is given by $-Z_{\alpha/2}$ and $Z_{\alpha/2}$ which can be obtained from the standard normal table.

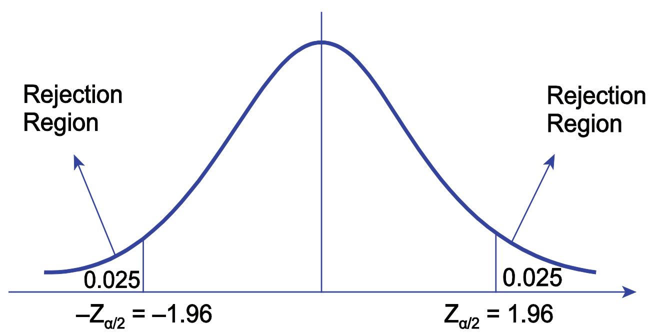


Fig 12.1 *Rejection regions for Example 12.1*

Since the computed value of Z = 13.47 lies in the rejection region, the null hypothesis is rejected. Therefore, it can be concluded that the average life of the bulb is significantly different from 1500 hours.

Alternative Approach to the Test of Hypothesis

There is an alternative approach called probability approach or simply p value approach to test the hypothesis. Under this approach, the researcher does not have to refer to Z table to determine the critical value. Referring to Example 12.1, the p value can be calculated as follows:

$$p = P(Z > 13.47) + P(Z < -13.47)$$

We know that the problem is that of a two-sided test and Z has a symmetric distribution, therefore,

$$p = 2P(Z > 13.47) = 2 \times 0 = 0$$

Now, the decision rule is:

Reject	H_0	if	$p \le \alpha$
Accept	H_0	if	$p > \alpha$

NOTES

In this example, $\alpha = 0.05$ and p value is less than α, so the null hypothesis is rejected. Therefore, it may be noted that the same conclusion is arrived at and there is no need to look at the critical value of Z as given in the statistical table. These days, most computer software like SPSS, EXCEL, SAS, MINITAB provide both the computed value of test statistic and the corresponding p value. Please note that the p value provided there is for the two-sided test. In case the problem is of a one-sided test, the reported p value is divided by 2 to obtain the desired p value for the problem and then compared with alpha (α), the level of significance so as to either accept or reject the null hypothesis. This is possible since Z-distribution is a symmetrical distribution.

Tests for Difference between Two Population Means

So far we have been concerned with the testing of means of a single population. We took up the cases of both large and small samples. It would be interesting to examine the difference between the two population means. Again, various cases would be examined as discussed below:

Case of Large Sample

In case both the sample sizes are greater than 30, a Z-test is used. The hypothesis to be tested may be written as:

$$H_0 : \mu_1 = \mu_2$$

$$H_1 : \mu_1 \neq \mu_2$$

where,

μ_1 = Mean of population 1

μ_2 = Mean of population 2

The above is a case of two-tailed test. The test statistic used is:

$$Z = \frac{(\bar{X}_1 - \bar{X}_2) - (\mu_1 - \mu_2)H_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

$\bar{X}_1$ = Mean of sample drawn from population 1

$\bar{X}_2$ = Mean of sample drawn from population 2

n_1 = Size of sample drawn from population 1

NOTES

n_2 = Size of sample drawn from population 2

If σ_1 and σ_2 are unknown, their estimates given by $\hat{\sigma}_1$ and $\hat{\sigma}_2$ are used.

$$\hat{\sigma}_1 = s_1 = \sqrt{\frac{1}{n_1 - 1}\sum_{i=1}^{n_1}(X_{1i} - \overline{X}_1)^2}$$

$$\hat{\sigma}_2 = s_2 = \sqrt{\frac{1}{n_2 - 1}\sum_{i=1}^{n_2}(X_{2i} - \overline{X}_2)^2}$$

The Z value for the problem can be computed using the above formula and compared with the table value to either accept or reject the hypothesis. Let us consider the following problem.

Example 12.2

A study is carried out to examine whether the mean hourly wages of the unskilled workers in the two cities—Ambala Cantt and Lucknow are the same. The random sample of hourly earnings in both the cities is taken and the results are presented in the Table 12.2.

Table 12.2 *Survey Data on Hourly Earnings in Two Cities*

City	Sample Mean Hourly Earnings	Standard Deviation of Sample	Sample Size
Ambala Cantt	₹8.95 ($\overline{X}_1$)	0.40 (s_1)	200 (n_1)
Lucknow	₹9.10 ($\overline{X}_2$)	0.60 (s_2)	175 (n_2)

Using a 5 per cent level of significance, test the hypothesis of no difference in the average wages of unskilled workers in the two cities.

Solution:

We use subscripts 1 and 2 for Ambala Cantt and Lucknow respectively.

$$H_0 \quad : \quad \mu_1 = \mu_2 \rightarrow \mu_1 - \mu_2 = 0$$

$$H_1 \quad : \quad \mu_1 \neq \mu_2 \rightarrow \mu_1 - \mu_2 \neq 0$$

The following survey data is given:

$\overline{X}_1 = 8.95$, $\overline{X}_2 = 9.10$, $s_1 = 0.40$, $s_2 = 0.60$, $n_1 = 200$, $n_2 = 175$, $\alpha = 0.05$

Since both n_1, n_2 are greater than 30 and the sample standard deviations are given, a Z-test would be appropriate.

The test statistic is given by

$$Z = \frac{(\overline{X}_1 - \overline{X}_2) - (\mu_1 - \mu_2)H_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

As σ_1, σ_2 are unknown, their estimates would be used.

$$s_1 = \hat{\sigma}_1, \qquad s_2 = \hat{\sigma}_2$$

$$\sqrt{\frac{\hat{\sigma}_1^2}{n_1}+\frac{\hat{\sigma}_2^2}{n_2}} = \sqrt{\frac{(0.4)^2}{200}+\frac{(0.6)^2}{175}} = \sqrt{0.0028} = 0.0053$$

$$Z = \frac{(8.95 - 9.10) - 0}{0.053} = -2.83$$

As the problem is of a two-tailed test, the critical values of Z at 5 per cent level of significance are given by $-Z_{\alpha/2} = -1.96$ and $Z_{\alpha/2} = 1.96$. The sample value of Z = –2.83 lies in the rejection region as shown in the figure below:

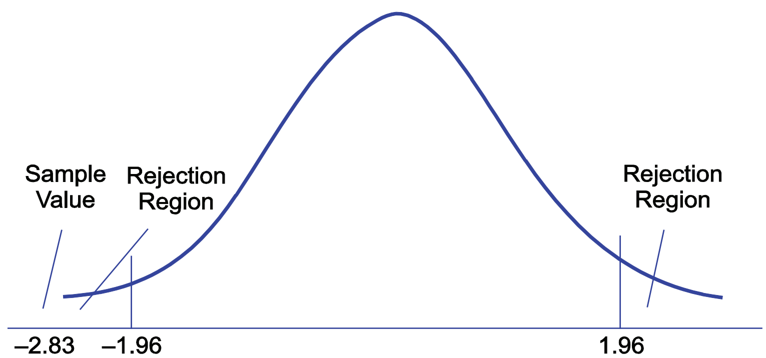


***Fig 12.2** Rejection regions for Example 12.2*

Therefore, the null hypothesis is rejected and it may be concluded that there is a difference in the average wages of unskilled workers in the two cities. Let us rework the same problem using the p value approach. As it is known that the problem is of a two-tailed test, the p value is given by:

$$\begin{aligned} p &= P(Z < -2.83) + P(Z > 2.83) \\ &= 2P(Z > 2.83) \\ &= 2 \times (0.5 - 0.4977) \\ &= 2 \times 0.0023 \\ &= 0.0046 \end{aligned}$$

As the value of p is less than α (0.05), the null hypothesis is rejected. Similarly, the problems on one-tailed tests can be solved.

12.3.2 Hypothesis Testing for Comparing Two Related Terms: T-test

The method for comparing two related samples in hypothesis testing is the paired **t-test**. For this test, it is necessary that the observations in the two samples should be collected in the form of matched pairs. It means that each observation in one sample must be paired with an observation in the other sample in such a way that they are matched excluding the other factors which do not fall within the area of this test.

An important formula for calculating this is:

$$\overline{D} = \frac{\sum D_i}{n}$$

And the formula for calculating the variances of the differences is:

$$(\sigma_{diff.})^2 = \frac{\sum D_i^2 - \left(\overline{D}\right)^2 \times n}{n-1}$$

Where, $\overline{D}$ = Mean of differences.

The t-test is based on t-distribution, which is a probability distribution that arises in the problem of estimating the mean of a normally distributed population when the sample size is small. t-distribution arises when the population standard deviation is unknown and has to be estimated from the data.

In Student's t-distribution, the random variable is assumed as X with mean μ and variance σ^2, $Z_{\bar{x}}$ the standard normal statistic is assumed as $\bar{X}$ and X^2 be a random variable, which follows chi-square distribution with t degrees of freedom.

If the variables are relatively independent with each other, then the t-distribution will be:

$$t = \frac{Z_{\bar{x}}}{\sqrt{\frac{X^2}{\tau}}}$$

The standard normal statistic of and chi-square statistics are:

$$Z_{\bar{x}} = \frac{\bar{X}}{\sigma / \sqrt{n}}$$

and

$$X^2 = \frac{(n-1)S^2}{\sigma^2}$$ with (n – 1) degrees of freedom.

After substituting these two statistics in t, t-distribution is represented as:

$$t = \frac{X - \mu}{S / \sqrt{n}}$$ with (n –1) degrees of freedom.

The t-distribution can be used only when the sample size is not more than 30; when the sample size is more than 30, then it can be approximated to a normal distribution.

12.3.3 Hypothesis Testing of Proportions, Difference between Proportions and Comparing Variance

NOTES

You can test proportions by using hypothesis testing. The formula for hypothesis testing of proportions is as follows:

Standard deviation of the proportion of successes $= \sqrt{\dfrac{p \times q}{n}}$.

If n is large, binomial distribution tends to become normal distribution. For proportion testing, you use static z as under:

$$Z = \frac{\hat{p} - p_0}{\sqrt{\dfrac{p_0 q_0}{n}}}$$

(b) Hypothesis testing for differences between proportions

If two samples are drawn from different populations, one may be interested in knowing whether the difference between the proportions is significant or not.

The formula for testing the significance of difference is as under:

$$z = \frac{\hat{p}_1 - \hat{p}_2}{\sqrt{\dfrac{\hat{p}_1 \times \hat{q}_1}{n_1} + \dfrac{\hat{p}_2 \times \hat{q}_2}{n_2}}}$$

Where, p_1 = Proportion of success in sample one

p_2 = Proportion of success in sample two

$q_1 = 1 \rightarrow p_1$

$q_2 = 1 \rightarrow p_2$

n_1 = Size of small one

n_2 = Size of sample two

Hypothesis testing for comparing a variance: Chi-square test

This test is used to compare a sample variance to some theoretical or hypothesized variance of population. It is different from z-test and t-test. The test used for this purpose is known as chi-square test. It is used to test null hypothesis.

The formula for this is as follows:

$$\chi^2 = \frac{\sigma_s^2}{\sigma_p^2}(n-1)$$

or

$$\frac{\text{Variance of the sample}}{\text{Variance of population}} \times \text{Degree of freedom}$$

Where n = number of items in the sample

By comparing the calculated value of chi-square test with n–1 degrees of freedom at a given level of significance, you can determine whether H_0 is accepted or rejected.

The chi-square test is based on the concept of chi-square distribution. This type of distribution is used when you are dealing with the collection of values that include adding up squares. Chi-square distribution is not symmetrical and all the values are positive. You need to know the degrees of freedom for using the chi-square distribution. The chi-square test is used for judging the significance of difference between observed (O_i) and expected (E_i) frequencies. The generalized shape of $\chi 2$ distribution depends on the degree of freedom and the $\chi 2$ (chi) is written as,

$$\chi^2 = \sum_{i=1}^{k} \frac{\left(O_i - E_i\right)^2}{E_i}$$

The chi-square test thus calculates the probability that no significant difference seems to exist between the expected frequency of an occurrence and the observed frequency of the same occurrence. The chi-square testing can be classified further as follows:

- **Chi-square** g**oodness of fit test**: This test is used for performing a comparison between a theoretical distribution and the observed data from a sample. As the name implies, it tests the fit between a theoretical frequency distribution and a frequency distribution of observed data.
- **Chi-square test of association**: The chi-square test of association facilitates comparing two attributes in a sample data. The comparison enables the researcher to determine whether there exists any relation between the two attributes.
- **Chi-square test of** h**omogeneity**: Here, the test is concerned with determining whether two populations have the same proportion of observations with a common characteristic.

Variance of samples requires adding a collection of squared quantities and thus having distribution that is related to chi-square distribution. The Chi-square distribution is a mathematical distribution that is used directly or indirectly in many tests of significance. The most common use of the chi-square distribution is to test differences among proportions. Figure 12.3 shows the chi-square distribution.

NOTES

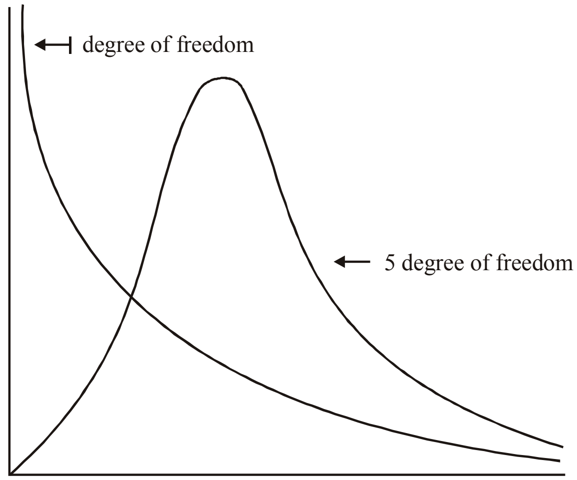


Fig. 12.3 *Chi-square Distribution*

The variance of the chi-square distribution is represented by:

$$S^2 = \frac{\sum (X_1 - \bar{X})^2}{n-1}$$

where

X_1 = observation of the sample

$\bar{X}$ = mean of the sample

n = size of the sample

The chi-square distribution is represented as:

$$X^2 = \frac{\sum_{i=1}^{n} (X_1 - \bar{X})^2}{\sigma^2} = \frac{(n-1)S^2}{\sigma^2}$$ with (n–1) degrees of freedom.

In the formula of chi-square distribution the variance of the distribution is represented as σ. This a random sample and from the normal population the size is taken with the variance that is known as chi-square (χ^2) distribution with (n–1) degrees of freedom.

12.3.4 Testing the Equality of Variances of Two Normal Populations: F-test

To test the equality of variances of two normal populations, the F-test is used, which is based on F-distribution.

The formula for this hypothesis testing is as follows:

$$F = \frac{\sigma_{s_1}^2}{\sigma_{s_2}^2}$$

NOTES

Where, $\sigma_{s_1}^2 = \frac{\sum\left(X_{1i}-\overline{X}_1\right)^2}{(n_1-1)}$ and

$$\sigma_{s_2}^2 = \frac{\sum\left(X_{2i}-\overline{X}_2\right)^2}{(n_2-1)}$$

The following presumptions are made while using F-test:

- The population samples are normal.
- Samples have been drawn randomly.
- Observations are independent.
- There is no measurement error.

To test the hypothesis, whether the two samples are from the same normal population with equal variance or from two normal populations with equal variances, the objects of F-test are used. It is also used to verify the hypothesis of equality between two variances. But, this test is now mostly used in the analysis of variance.

The F-test depends on F distribution, which is an asymmetric distribution that has a minimum value of 0, but no maximum value. The curve reaches a peak not far to the right of 0, and then approaches the horizontal axis. Figure 12.4 shows the F distribution.

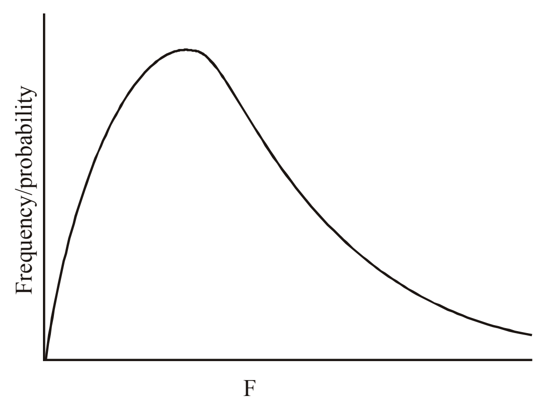


Fig. 12.4 *F Distribution*

In F distribution, (n_1-1) and (n_2-1) are the degrees of the freedom of the F distribution, which is represented as:

$$F = \frac{\frac{(n_1-1)S_1^2/\sigma_1^2}{n_1 - 1}}{\frac{(n_2-1)S_2^2/\sigma_2^2}{n_2 - 1}}$$ with (n_1-1) and (n_2-1) are the degrees of freedom.

If $\sigma_1 = \sigma_2$, then the formula of F distribution will be represented as:

$F = \frac{S_1^2}{S_2^2}$ with $(n_1 - 1)$ and $(n_2 - 1)$ are the degrees of the freedom.

NOTES

Hypothesis testing of correlation coefficients

To know the significance of correlation coefficient based on sample data, the following formulae are applied:

- For simple correlation coefficient: $t = r_{yx}\sqrt{\frac{n-2}{1-r_{yx}^2}}$, null hypothesis is either accepted or rejected based on the value of t.
- For partial correlation coefficient: $t = r_p\sqrt{\frac{(n-k)}{1-r_p^2}}$, null hypothesis is either accepted or rejected based on the value of t.

12.4 STATISTICAL TECHNIQUES OF HYPOTHESIS TESTING

The statistical techniques of hypothesis testing involves proving a statement that acts as an alternative for the hypothesis. There are several types of statistical techniques employed in hypothesis testing which can be explained with suitable examples.

(a) Hypothesis testing of means

There are different situations under hypothesis testing of means. The testing technique is different in different situations, which are as follows:

- If population is normal, population is infinite, sample size that can be large or small and the variance of population is known, then, Ha may be one-sided or two-sided. In such a situation, z-test is used and formula for this is as follows:

$$z = \frac{\overline{X} - \mu_{H_0}}{\sigma_p/\sqrt{n}}$$

- If population is normal, population is finite, sample size that can be large or small and the variance of population is known, then, Ha may be one-sided or two-sided.

  The formula for this situation is as follows:

$$z = \frac{\overline{X} - \mu_{H_0}}{\left(\sigma_p/\sqrt{n}\right) \times \left[\sqrt{(N-n)/(N-1)}\right]}$$

NOTES

- If population is normal, population is infinite, sample size is small and variance of the population is unknown, then, H_a may be one-sided or two-sided.

  The formula for this situation is as follows:

$$z = \frac{\overline{X} - \mu_{H_0}}{\left(\sigma_p/\sqrt{n}\right) \times \left[\sqrt{(N-n)/(N-1)}\right]}$$

and

- If population is normal, population is finite, sample size is small and variance of the population is unknown, then, H_a may be one-sided or two-sided.

  The formula for this situation is as follows:

$$t = \frac{\overline{X} - \mu_{H_0}}{\sigma_s/\sqrt{n}} \quad \text{and} \quad \sigma_s = \sqrt{\frac{\sum (X_i - \overline{X})^2}{(n-1)}}$$

- If population is not normal but sample size is large, variance of the population is known or unknown, then, H_a may be one-sided or two-sided.

  The formula for this situation is as follows:

$$z = \frac{\overline{X} - \mu_{H_0}}{\sigma_p \big/ \sqrt{n}} \quad \boxed{\text{OR}} \quad z = \frac{\overline{X} - \mu_{H_0}}{\left(\sigma_p/\sqrt{n}\right) \times \sqrt{(N-n)/(N-1)}}$$

(b) Hypothesis testing for difference between means

There are situations where the significance of difference between the two means is examined. Such situations are stated along with their respective formulas:

- Population variances are known or the samples happen to be large samples. The formula used under this situation is as follows:

$$z = \frac{\overline{X_1} - \overline{X_2}}{\sqrt{\frac{\sigma^2_{p_1}}{n_1} + \frac{\sigma^2_{p_2}}{n_2}}}$$

In case σ_{p1} and σ_{p2} are not known, σ_{s1} and σ_{s2} are used in the same formula, which can be rewritten as:

$$\sigma_{s_1} = \sqrt{\frac{\sum\left(X_{1i} - \overline{X}_1\right)^2}{n_1 - 1}} \quad \text{and} \quad \sigma_{s_2} = \sqrt{\frac{\sum\left(X_{2i} - \overline{X}_2\right)^2}{n_2 - 1}}$$

- Samples happen to be large but presumed to have been drawn from the same population whose variance is known.

The formula used under this situation is as follows:

$$z = \frac{\overline{X_1} - \overline{X_2}}{\sqrt{\sigma_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

In case σ_p is not known, $\sigma s_{1.2}$ (combined standard deviation of both the samples) is used. The formula thus obtained after replacing it is as follows:

$$\sigma_{s_{1,2}} = \sqrt{\frac{n_1\left(\sigma_{s_1}^2 + D_1^2\right) + n_2\left(\sigma_{s_2}^2 + D_2^2\right)}{n_1 + n_2}}$$

Where $D_1 = \overline{X}_1 - \overline{X}_{1.2}$ and $D_2 = \overline{X}_2 - \overline{X}_{1.2}$

and $$X_{1,2} = \frac{n_1\overline{X}_1 + n_2\overline{X}_2}{n_1 + n_2}$$

- Samples happen to be small and population variances are not known but assumed to be equal.

  The formula for this situation is as under:

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\frac{\sum\left(X_{1i} - \overline{X}_1\right)^2 + \sum\left(X_{2i} - \overline{X}_2\right)^2}{n_1 + n_2 - 2}} \times \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

OR

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\frac{\sum(n_1 - 1)\sigma_{s_1}^2 + (n_2 - 1)\sigma_{s_2}^2}{n_1 + n_2 - 2}} \times \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

12.5 CHI-SQUARE TEST AND CONTINGENCY TABLE

From the observation (of data), different statistics are constructed to estimate the population parameters. In general (but not always) the sampling distribution of these statistics depends on the parameters and form of the parent population. The difference between distributions have been previously studied through constants like mean, standard deviation, etc., which are the estimates of the parameters, but generally these do not give all the features of these distributions. This caused the necessity to have some index which can measure the degrees of difference between the actual frequencies of the various groups and can thus compare all necessary features of them. An index of this type is "Karl Pearson's χ^2 (chi-square)" which is used to measure the deviations of observed frequencies in an experiment from the expected

NOTES

frequencies obtained from some hypothetical universe. Here, we are going to study a distribution called χ^2-distribution which enables us to compare a whole set of sample values with a corresponding set of hypothetical values.

χ^2 distribution was discovered in 1875 by Helmert and was again discovered independently in 1900 by Karl Pearson who applied it as a test of goodness of fit.

Definition of χ^2 (Or Chi-square)

If f_o and f_e denote the observed and corresponding expected frequencies of a class interval (or cell), then chi-square is defined by the relation:

$$\chi^2 = \Sigma\left\{\frac{(f_o - f_e)^2}{f_e}\right\}$$

where the summation extends to the whole set of class-intervals.

Another form of χ^2 is obtained as follows:

$$\chi^2 = \Sigma\left\{\frac{(f_o - f_e)^2}{f_e}\right\} = \Sigma\left\{\frac{f_o^2 + f_e^2 - 2.f_o f_e}{f_e}\right\}$$

$$= \Sigma\left\{\frac{f_o^2}{f_e} + f_e - 2f_o\right\}$$

$$= \left\{\Sigma\left(\frac{f_o^2}{f_e}\right) + \Sigma f_e - 2\Sigma f_o\right\}$$

$$= \Sigma\left(\frac{f_o^2}{f_e}\right) + N - 2N$$

$(\therefore \Sigma f_e = \Sigma f_o = N$, the total frequency)

$$\chi_{2208} = \Sigma\left(\frac{f_o^2}{f_e}\right) - N$$

Note: It can be proved that if $x_1, x_2,$ •••, x_n be in n independent normal variates each having zero mean and unit variance, then the sum of the squares of these n variates i.e., $\left(x_1^2 + x_2^2 + ... + x_n^2\right)$ is a statistic called χ^2 with 'n' degrees of freedom or a stochastic variate having χ2 distribution with 'n' degrees of freedom (The no. of independent variates is called the no. of degrees of freedom).

Degrees of Freedom and Constraints

Let the individuals of a sample be grouped into 'n' classes or cells but instead of these being independent, let those be subject to 'v' independent linear constraints, then the no. of degrees of freedom n is defined by the relation $v = (n - c)$.

$$\text{i.e., } \begin{pmatrix}\text{degrees}\\ \text{of freedom}\end{pmatrix} = \begin{pmatrix}\text{no. of}\\ \text{groups}\end{pmatrix} - \begin{pmatrix}\text{no. of linear}\\ \text{constraints}\end{pmatrix}$$

Note: Each independent linear constraint reduces the no. of degrees of freedom by one.

The Chi-square Distribution

NOTES

For large sample size, the sampling (probability) distribution of χ^2 can be closely approximated by a continuous curve known as the **chi-square distribution**.

The probability function of χ^2 distribution is given by

$$F(\chi^2) = c\left(\chi^2\right)^{(v^2-1)} \cdot e^{\chi^2/2}$$

where $e = 1 + \frac{1}{1!} + \frac{1}{2!} + \ldots \textit{ ad inf}$

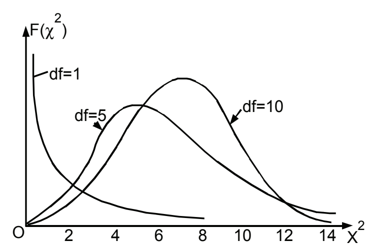
$= 2.71828$

υ = no. of degrees of freedom

c = a constant depending only on υ.

The chi-square distribution has only one parameter υ, the no. of degrees of freedom. This is similar to the case of the *t*-distribution. Hence $f(\chi 2)$ is a family of distributions, one for each value of υ.

Important Properties of the Distribution



(i) χ^2 distribution is a continuous probability distribution which has the value zero at its lower limit and extends to infinity in the positive direction. Negative value of χ^2 is not possible (since the differences between the observed and expected frequencies are always squared).

(ii) The exact shape of distribution depends upon the no. of degrees of freedom υ. For different values of υ, we shall have different shapes of distribution. In general, when υ is small, the shape of the curve is skewed to the right and as υ gets larger, the distribution becomes more and more symmetrical and can be approximated by the normal distribution.

(iii) The mean of the χ^2 distribution is given by the degrees of freedom i.e., $E(\chi^2) = \upsilon$ and variance is twice the degrees of freedom, i.e., $V(\chi^2) = 2\upsilon$.

(iv) As υ gets larger, χ^2 approaches the normal distribution with mean υ and standard deviation $\sqrt{2v}$. In practice, it has been determined that the quantity $\sqrt{2\chi^2}$ provides a better approximation to normality than

χ^2 itself for values of 30 or more. The distribution of $\sqrt{2\chi^2}$ has a mean equal to $\sqrt{(2v-1)}$ and a standard deviation equal to 1.

(v) The sum of independent χ^2 variates is also a χ^2 variate. Therefore, if χ_1^2 is a χ^2 variate with υ_1 degrees of freedom and χ_2^2 is another χ^2 variate with υ_2 degrees of freedom, then their sum $\left(\chi_1^2+\chi_2^2\right)$ is also a χ^2 variate with $(\upsilon_1 + \upsilon_2)$ degrees of freedom. This property is known as the additive property of χ^2.

Contingency Table

Let the given data be classified into p classes A_1, A_2, •••, Ap according to attribute x and into q classes B_1, B_2, ••, B_q according to attribute y. Let f_{ij} devote the observed frequency of the cell belonging to both the classes A_i ($i = 1, 2$, •••, p) and B_j ($j = 1, 2$, •••, q).

Let the total of all the frequencies belonging to the class A_i be denoted by (A_i) and similarly let (B_j) denote the total of all the frequencies belonging to the class B_j. Then the given data can be set into a table of r rows and s columns in the following manner:

Classes	B_1	B_2	•••	B_j	•••	B_{q-1}	B_q	*Totals*
A_1	f_{11}	f_{12}	•••	f_{1j}	•••	$f_{1,\,q-1}$	f_{1q}	(A_1)
A_2	f_{21}	f_{22}	•••	f_{2j}	•••	$f_{2,\,q-1}$	f_{2q}	(A_2)
•••	•••	•••	•••	•••	•••	•••	•••	•••
•••	•••	•••	•••	•••	•••	•••	•••	•••
•••	•••	•••	•••	•••	•••	•••	•••	•••
A_i	f_{i1}	f_{i2}	•••	f_{ij}	•••	$f_{i,\,q-1}$	f_{iq}	(A_i)
•••	•••	•••	•••	•••	•••	•••	•••	•••
•••	•••	•••	•••	•••	•••	•••	•••	•••
•••	•••	•••	•••	•••	•••	•••	•••	•••
A_{p-1}	$f_{p-1,\,1}$	$f_{p-1,\,2}$	•••	$f_{p-1,\,j}$	•••	$f_{p-1,\,q-1}$	$f_{P-1,\,q}$	(A_{P-1})
A_p	f_{p1}	f_{p2}	•••	f_{pj}	•••	$f_{p,\,q-1}$	f_{Pq}	(A_P)
Totals	(B_1)	(B_2)	•••	(B_j)	•••	(Bq_{-1})	(Bq)	$N.$

Calculation of υ for Contingency Table

The theoretical frequencies in a contingency table are calculated by imposing the limitations that the row totals, column totals and the grand total remain constant (i.e., unchanged). Therefore, if there be p rows and q columns, then each of p row totals and q column–totals gives rise to one constraint and so we have $(p + q)$ constraints. But, the sum of the border rows and the sum of the border columns must each be equal to the grand total and so one constraint is diminished and so there are only $(p + q - 1)$ constraints.

NOTES

So, the no. of degrees of freedom is given as follows:

$$\upsilon = (n - c)$$
$$= [pq - (p + q - 1)] = [pq - p - q + 1]$$
$$= [p\,(q - 1) - (q - 1)] = (p - 1)\,(q - 1)$$

Check Your Progress

3. What is a parametric test?
4. What is chi-square distribution?

12.6 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. Hypothesis testing can be broadly divided into two types, which are as follows:
   - Parametric tests or standard tests of hypothesis
   - Non-parametric tests or distribution-free tests of hypothesis
2. Fisher–Irwin test is applied where there is no difference between two sets of data.
3. A parametric statistical test is one that makes assumptions about the parameters (defining properties) of the population distribution(s) from which one's data are drawn.
4. For large sample size, the sampling (probability) distribution of χ^2 can be closely approximated by a continuous curve known as the chi-square distribution.

12.7 SUMMARY

- The first step of the testing procedure is to establish the hypothesis to be tested. As it is known, these statistical hypotheses are generally assumptions about the value of the population parameter; the hypothesis specifies a single value or a range of values for two different hypotheses rather than constructing a single hypothesis.
- The two hypotheses are generally referred to as the (1) null hypotheses denoted by H_0 and (2) alternative hypothesis denoted by H_1.
- The hypothesis may be rejected or accepted depending upon whether the value of the test statistic falls in the rejection or the acceptance region.
- Hypothesis testing can be broadly divided into two types, which are as follows:

NOTES

- o Parametric tests or standard tests of hypothesis
- o Non-parametric tests or distribution-free tests of hypothesis

- Parametric tests assume certain properties of the population sample such as observations from a normal population, large sample size, population parameters like mean and variance.
- McNamara test is applied where the data is nominal in nature and is related to two interrelated samples.
- The method for comparing two related samples in hypothesis testing is the paired t-test.
- The statistical techniques of hypothesis testing involves proving a statement that acts as an alternative for the hypothesis.
- From the observation (of data), different statistics are constructed to estimate the population parameters. In general (but not always) the sampling distribution of these statistics depends on the parameters and form of the parent population.
- The theoretical frequencies in a contingency table are calculated by imposing the limitations that the row totals, column totals and the grand total remain constant (i.e., unchanged).

12.8 KEY WORDS

- **T-Test:** It is any statistical hypothesis test in which the test statistic follows a Student's t-distribution under the null hypothesis.
- **Z-Test:** It is any statistical test for which the distribution of the test statistic under the null hypothesis can be approximated by a normal distribution
- **F-Test:** It is any statistical test in which the test statistic has an F-distribution under the null hypothesis.
- **Chi-Test:** It is any statistical hypothesis test where the sampling distribution of the test statistic is a chi-squared distribution when the null hypothesis is true.

12.9 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. What are non-parametric tests?
2. What is the F-test?
3. How is chi-square testing classified?
4. List the important properties of chi-square distribution.

Long-Answer Questions

1. Describe the various steps of the testing procedure.
2. Illustrate how to test the difference between two population means.
3. Examine the hypothesis test for comparing two related terms.
4. Describe the chi-square test.

NOTES

12.10 FURTHER READINGS

Creswell, John W. 2002. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. London: Sage Publications Inc.

Booth, Wayne, Gregory G. Colomb and Joseph M. Williams. 1995. *The Craft of Research*. Chicago: University of Chicago Press.

Bryman, Alan and Emma Bell. 2015. *Business Research Methods.* 4th Edition. United Kingdom: Oxford University Press.

Gupta, S.L. and Hitesh Gupta. 2012. *Business Research Methods.* New Delhi: Tata McGraw Hill Education Private Limited.

UNIT 13 OVERVIEW OF NON-PARAMETRIC TESTS

NOTES

Structure

13.0 Introduction
13.1 Objectives
13.2 Non-Parametric Test: Concept and Types
    13.2.1 Mann-Whitney Test
    13.2.2 Kruskal Wallis
    13.2.3 Sign Test
13.3 Multivariate Analysis
    13.3.1 Factor Analysis
    13.3.2 Cluster
    13.3.3 Multidimensional Scaling (MDS)
    13.3.4 Discriminant Analysis
13.4 The Process of Interpretation of Test Results
    13.4.1 Guidelines for Making Valid Interpretation
13.5 Answers to Check Your Progress Questions
13.6 Summary
13.7 Key Words
13.8 Self Assessment Questions and Exercises
13.9 Further Readings

13.0 INTRODUCTION

In the previous unit, you primarily learnt about the different parametric tests. In this unit, we will discuss non-parametric tests. As we have learnt, non-parametric tests are sometimes called distribution-free tests because they are based on fewer assumptions (e.g., they do not assume that the outcome is approximately normally distributed). The cost of fewer assumptions is that nonparametric tests are generally less powerful than their parametric counterparts (i.e., when the alternative is true, they may be less likely to reject H_0). We will discuss the different types of non-parametric tests in this unit. The concept of multivariate analysis is also explained here.

13.1 OBJECTIVES

After going through this unit, you will be able to:

- Discuss the different types of non-parametric tests
- Examine multivariate analysis
- Describe the process of interpreting tests results

13.2 NON-PARAMETRIC TEST: CONCEPT AND TYPES

NOTES

As you have learnt, there are situations where assumptions cannot be made. In such situations, different statistical methods are used, which are known as non-parametric tests. Thus, we can say that a non-parametric test is a test that does not assume anything about the underlying distribution. It is sometimes called a distribution free test. There are various types of non-parametric tests. These include: •

- Sign test: They include one-sample sign test and two-sample sign test.
- Fisher–Irwin test
- McNamara test
- Wilcoxon matched-pairs test

13.2.1 Mann-Whitney Test

This test was developed by H B Mann and R Whitney in the 1940s. The test is used to examine whether two samples have been drawn from populations with same locations (mean). The application of a t test involves the assumption that the samples are drawn from the normal population. If the normality assumption is violated, this test can be used as an alternative to a t test. This is a very powerful non-parametric test as this can be used both for qualitative and quantitative data. A two tailed hypothesis for a Mann-Whitney test could be written as:

H_0 : Two samples come from identical populations

or

Two populations have identical probability distribution.

H_1 : Two samples come from different populations

or

Two populations differ in locations.

The procedure involved in the use of Mann-Whitney U test is very simple and is described in the following steps:

(i) The two samples are combined (pooled) into one large sample and then we determine the rank of each observation in the pooled sample. If two or more sample values in the pooled samples are identical, i.e., if there are ties, the sample values are each assigned a rank equal to the mean of the ranks that would otherwise be assigned.

(ii) We determine the sum of the ranks of each sample. Let R_1 and R_2 represent the sum of the ranks of the first and the second sample whereas n_1 and n_2 are the respective sample sizes of the first and the second

NOTES

sample. For convenience, choose n1 as a small size if they are unequal so that $n_1 \leq n_2$. A significant difference between R_1 and R_2 implies a significant difference between the samples.

(iii) Define $U_1 = n_1 n_2 + \dfrac{n_1(n_1+1)}{2} - R_1$

and $U_2 = n_1 n_2 + \dfrac{n_2(n_2+1)}{2} - R_2$

Please note that the following expression will hold true:

$$U_1 = U_2 = n_1 n_2$$

Mann-Whitney test for a large sample: If n_1 or n_2 is greater than 10, a large sample approximation can be used for the distribution of the Mann-Whitney U statistic. For this purpose, either of U_1 or U_2 could be used for testing a one-tailed or a two-tailed test. In this test, U_2 will be used for the purpose.

Under the assumption that the null hypothesis is true, the U_2 statistic follows an approximately normal distribution with mean:

$$\mu_{u_2} = \frac{n_1 n_2}{2}$$

$$\sigma_{u_2} = \sqrt{\frac{n_1 n_2 (n_1+n_2+1)}{12}}$$

The test statistic is:

$$Z = \frac{U_2 - \mu_{u_2}}{\sigma_{u_2}}$$

Assuming the level of significance as equal to a, if the absolute sample value of Z is greater than the absolute critical value of Z, i.e., $Z_{\alpha/2}$, the null hypothesis is rejected. A similar procedure is used for a one tailed test. For a one sided upper tail test if the sample value of Z is greater than the critical Z_α, the null hypothesis is rejected. For a one-sided lower tail test, the null hypothesis is rejected if the sample Z is less than $-Z_\alpha$.

13.2.2 Kruskal Wallis

One of the assumptions used in the ANOVA technique is that all the involved populations from where the samples are taken are normally distributed. If this assumption does not hold true, the F-statistic used in ANOVA becomes invalid. The normality assumptions may not hold true when we are dealing with ordinal data or when the size of the sample is very small.

The Kruskal-Wallis test comes to our rescue during such situations. This is, in fact, a non-parametric counterpart to the one-way ANOVA. The test is an extension of the Mann-Whitney U test discussed earlier. Both methods require that the scale of the measurement of a sample value should be at least ordinal.

The hypothesis to be tested in-Kruskal-Wallis test is:

H_0 : The k populations have identical probability distribution.

H_1 : At least two of the populations differ in locations.

The procedure for the test is listed below:

(i) Obtain random samples of size n_1, ..., nk from each of the k populations. Therefore, the total sample size is $n = n_1 + n_2 + ... + n_k$

(ii) Pool all the samples and rank them, with the lowest score receiving a rank of 1. Ties are to be treated in the usual fashion by assigning an average rank to the tied positions.

(iii) Let r_i = the total of the ranks from the i^{th} sample.

The Kruskal-Wallis test uses the χ^2 to test the null hypothesis. The test statistic is given by:

$$H = \frac{12}{n(n+1)} \sum_{i=1}^{k} \frac{r_i^2}{n_i} - 3(n+1),$$

which follows a χ^2 distribution with the k–1 degrees of freedom.

where, k = Number of samples

n = Total number of elements in k samples.

The null hypothesis is rejected, if the computed χ^2 is greater than the critical value of χ^2 at the level of significance α.

13.2.3 Sign Test

The Mann-Whitney U test just discussed assumes that the two samples are independent. However, there are instances when the normality assumption is not satisfied and one has to resort to a non-parametric test. One such test earlier discussed was the two-sample sign test. In this test, only the sign of the difference (positive or negative) was taken into account and no weightage was assigned to the magnitude of the difference. The Wilcoxon matched-pair signed rank test takes care of this limitation and attaches a greater weightage to the matched pair with a larger difference. The test, therefore, incorporates and makes use of more information than the sign test. This is, therefore, a more powerful test than the sign test.

The test procedure is outlined in the following steps:

(i) Let di denote the difference in the score for the i^{th} matched pair. Retain signs, but discard any pair for which d = 0.

(ii) Ignoring the signs of difference, rank all the di's from the lowest to highest. In case the differences have the same numerical values, assign to them the mean of the ranks involved in the tie.

(iii) To each rank, prefix the sign of the difference.

NOTES

(iv) Compute the sum of the absolute value of the negative and the positive ranks to be denoted as T– and T+ respectively.

(v) Let T be the smaller of the two sums found in step iv.

When the number of the pairs of observation (n) for which the difference is not zero is greater than 15, the T statistic follows an approximate normal distribution under the null hypothesis, that the population differences are centred at 0. The mean μ_T and standard deviation σ_T of T are given by:

$$\mu_T = \frac{n(n+1)}{4} \quad \text{and} \quad \sigma_T = \sqrt{\frac{n(n+1)(2n+1)}{24}}$$

The test statistic is given by:

$$Z = \frac{T - \dfrac{n(n+1)}{4}}{\sqrt{\dfrac{n(n+1)(2n+1)}{24}}}$$

For a given level of significance α, the absolute sample Z should be greater than the absolute $Z_{\alpha/2}$ to reject the null hypothesis. For a one-sided upper tail test, the null hypothesis is rejected if the sample Z is greater than Z_α and for a one-sided lower tail test, the null hypothesis is rejected if sample Z is less than $-Z_\alpha$.

13.3 MULTIVARIATE ANALYSIS

Let us now discuss multivariate analysis.

13.3.1 Factor Analysis

Factor analysis is a multivariate statistical technique in which there is no distinction between dependent and independent variables. In factor analysis, all variables under investigation are analysed together to extract the underlined factors. Factor analysis is a data reduction method. It is a very useful method to reduce a large number of variables resulting in data complexity to a few manageable factors. These factors explain most part of the variations of the original set of data. A market researcher might have collected data on say, more than 50 attributes (or items) of a product which may become very difficult to analyse. Factor analysis could help to reduce the data on 50 odd attributes to a few manageable factors. It helps in identifying the underlying structure of the data.

A *factor* is a linear combination of variables. It is a construct that is not directly observable but that needs to be inferred from the input variables. The factors are statistically independent. We will show you their application in a

regression analysis as the factor scores, when used as independent variables in regression analysis, help to solve the problem of multicollinearity. (The problem of multicollinearity in a regression model arises when the independent variables are so highly correlated that it becomes difficult to separate out the influence of each of the independent variables on the dependent variable.) The factor scores could also be used in other multivariate techniques.

NOTES

Uses of Factor Analysis

The technique of factor analysis has multiple uses as discussed in the following situations:

Scale construction: Factor analysis could be used to develop concise multiple item scales for measuring various constructs. We have already discussed in the chapter Attitude Measurement and Scaling the process of developing a multiple item scale that typically starts generating a large set of items (statements) relating to the attitude being measured. This is done as part of exploratory research. Factor analysis can reduce the set of statements to a concise instrument and at the same time, ensure that the retained statements adequately represent the critical aspects of the constructs being measured. Suppose we want to prepare a multiple item scale for measuring the job satisfaction of skilled workers in an organization. As the first step, we would generate a large number of statements, numbering say 100 or so as part of exploratory research. These statements could be subjected to factor analysis and let us assume that we get three factors out of it. Now, if we want to construct a 15-item scale to measure job satisfaction, what could be done is to separate five items in each of the factors having the highest factor loading. The concept of factor loading will be discussed later in the book. This way, a 15-item scale to measure job satisfaction could be developed.

Establish antecedents: This method reduces multiple input variables into grouped factors. Thus, the independent variables can be grouped into broad factors. For example, all the variables that measure the safety clauses in a mutual fund could be reduced to a factor called safety clause. Thus, the company could know about the broad benefit that an investor seeks in a fund.

Psychographic profiling: Different independent variables are grouped to measure independent factors. These are then used for identifying personality types. One of the most well-known inventories based on this technique is called the 16 PF inventory.

Segmentation analysis: Factor analysis could also be used for segmentation. For example, there could be different sets of two-wheelers-customers owning two wheelers because of different importance they give to factors like prestige, economy consideration and functional features.

Marketing studies: The technique has extensive use in the field of marketing and can be successfully used for new product development; product

NOTES

acceptance research, developing of advertising copy, pricing studies and for branding studies. For example we can use it to:

- identify the attributes of brands that influence consumers' choice;
- get an insight into the media habits of various consumers;
- identify the characteristics of price-sensitive customers.

Conditions for a Factor Analysis Exercise

Factor analysis requires some specific conditions that must be ensured before executing the technique. These are mentioned in detail in this section.

- Factor analysis exercise requires metric data. This means the data should be either interval or ratio scale in nature. The variables for factor analysis are identified through exploratory research which may be conducted by reviewing the literature on the subject, researches carried out already in this area, by informal interviews of knowledgeable persons, qualitative analysis like focus group discussions held with a small sample of the respondent population, analysis of case studies and judgement of the researcher. Generally in a survey research, a five or seven-point Likert scale or any other interval scales may be used.
- As the responses to different statements are obtained through different scales, all the responses need to be standardized. The standardization helps in comparison of different responses from such scales. The standardization is carried out using the following formulae:

  Standardized score of ith respondent on a statement =

  $$\frac{\text{Actual score of } i^{th} \text{ respondent on statement} - \text{Mean of all respondents on the statement}}{\text{Standard deviation of all respondents on the statement}}$$

- The size of the sample respondents should be at least four to five times more than the number of variables (number of statements).
- The basic principle behind the application of factor analysis is that the initial set of variables should be highly correlated. If the correlation coefficients between all the variables are small, factor analysis may not be an appropriate technique. A correlation matrix of the variables could be computed and tested for its statistical significance. The hypothesis to be tested may be written as:

  H_0 : Correlation matrix is insignificant, i.e., correlation matrix is an identity matrix where diagonal elements are one and off diagonal elements are zero.

  H_1 : Correlation matrix is significant.

  The test is carried out by using a Bartlett test of sphericity, which takes the determinant of the correlation matrix into consideration. The test converts it into a chi-square statistics with degrees of freedom equal

to [(k(k-1))/2], where k is the number of variables on which factor analysis is applied. The significance of the correlation matrix ensures that a factor analysis exercise could be carried out.

NOTES

- Another condition which needs to be fulfilled before a factor analysis could be carried out is the value of Kaiser-Meyer-Olkin (KMO) statistics which takes a value between 0 and 1. For the application of factor analysis, the value of KMO statistics should be greater than 0.5. The KMO statistics compares the magnitude of observed correlation coefficients with the magnitudes of partial correlation coefficients. A small value of KMO shows that correlation between variables cannot be explained by other variables.

Steps in a Factor Analysis Exercise

There are basically two steps that are required in a factor analysis exercise.

1. **Extraction of factors:** The first and the foremost step is to decide on how many factors are to be extracted from the given set of data. This could be accomplished by various methods like the centroid method, the principal component method and the maximum likelihood method. Here, only the principal component method will be discussed very briefly. As we know that factors are linear combinations of the variables which are supposed to be highly correlated, the mathematical form of the same could be written as:

$$F_i = W_{i1}X_1^* + W_{i2}X_2^* + W_{i3}X_3^* + ... + W_{ik}X_k^*$$

where,

X_i^* = i^{th} standardized variable

F_i = Estimate of i^{th} factor

W_i = Weight or factor score coefficient for i^{th} standardized variable.

k = Number of variables

The principal component methodology involves searching for those values of W_i so that the first factor explains the largest portion of total variance. This is called the first principal factor. This explained variance is then subtracted from the original input matrix so as to yield a residual matrix. A second principal factor is extracted from the residual matrix in a way such that the second factor takes care of most of the residual variance. One point that has to be kept in mind is that the second principal factor has to be statistically independent of the first principal factor. The same principle is then repeated until there is little variance to be explained. Theory may be used to specify how many factors should be extracted or it may be based on the criterion

NOTES

of the Kaiser Guttman method. This method states that the number of factors to be extracted should be equal to the number of factors having an eigenvalue of at least 1. Since each of the variables in the original data set has a variance of 1 (eigenvalue of 1), therefore, if there are 50 variables then the total variation in the data set will be 50.

We know that a factor is a linear combination of the various variables. Now eigenvalue for each of the factor is computed and only those factors that have an eigenvalue at least 1 are accepted as per Kaiser Guttman method. All those factors having eigenvalues less than 1 are rejected. This is because each of the variables has a variance of 1 and, therefore, a linear combination of these variables called factor should not have an eigenvalue less than 1.

Another output of the factor analysis exercise is a *factor score*, which is computed for each of the factors corresponding to each respondent. Most software, including SPSS, provide factor score for each respondent and each factor. As the factor scores are statistically independent, they can be used in regression and discriminant analysis as independent variables. This will be explained briefly in the text later on.

The correlation coefficient of the extracted factor score with a variable is called the *factor loading*. In most computer printouts, a matrix of factor loadings called factor matrix or component matrix is presented. Factor loadings play a very important role in the computations of eigenvalues of each factor and also in computing the communalities of each variable. These concepts would be discussed in depth with the help of a numerical exercise.

2. **Rotation of factors:** The second step in the factor analysis exercise is the rotation of initial factor solutions. This is because the initial factors are very difficult to interpret. Therefore, the initial solution is rotated so as to yield a solution that can be interpreted easily. Most of the computer software would give options for *orthogonal rotation, varimax rotation* and *oblique rotation*. Generally, the varimax rotation is used as this results in independent factors. The varimax rotation method maximizes the variance of the loadings within each factor. The variance of the factor is largest when its smallest loading tends towards zero and its largest loading tends towards unity. The basic idea of rotation is to get some factors that have a few variables that correlate high with that factor and some that correlate poorly with that factor. Similarly, there are other factors that correlate high with those variables with which the other factors do not have significant correlation. Therefore, the rotation is carried out in such way so that the factor loadings as in the

first step are close to unity or zero. This procedure avoids problems of having factors with all variables having midrange correlations. This is done for a better interpretation of the results and for the ease obtained in naming the factors. Once this is done, a cut-off point on the factor loading is selected. There is no hard and fast rule to decide on the cut-off point. However, generally it is taken to be greater than 0.5. All those variables attached to a factor, once the cut-off point is decided, are used for naming the factors. This is a very subjective procedure and different researchers may name same factors differently. Another point to be noted is that a variable which appears in one factor should not appear in any other factor. This means that a variable should have a high loading only on one factor and a low loading on other factors. If that is not the case, it implies that the question has not been understood properly by the respondent or it may not have been phrased clearly. Another possible cause could be that the respondent may have more than one opinion about a given item (statement).

The total variance explained by all the factors taken together remains the same after rotation. However, the amount of variations for each individual factor may undergo a change. The communalities for each variable under the two procedures remain unchanged.

13.3.2 Cluster

Cluster analysis is a grouping technique. The basic assumption underlying the technique is the fact that similarity is based on multiple variables, and the technique attempts to measure the proximity in terms of the study variables. The emerging groups are homogenous in their composition and heterogeneous as compared to the other groups. The grouping can be done for objects, individuals, entities and products. The researcher identifies a set of clustering variables which have been assumed as significant for the purpose of classifying the objects into groups. Thus, it is also referred to as a classification technique, numerical taxonomy and Q analysis. This is basically because the technique is used in various branches of social science, like psychology, sociology, engineering and management. If one were to plot the groups geometrically, a robust cluster analysis is one where individual objects in one cluster are concentrated together and where the individual clusters are far apart from each other. Figure 13.1(a) shows a simple cluster solution of breakfast food based on people who seek nutrition and convenience (ease of preparation).

NOTES

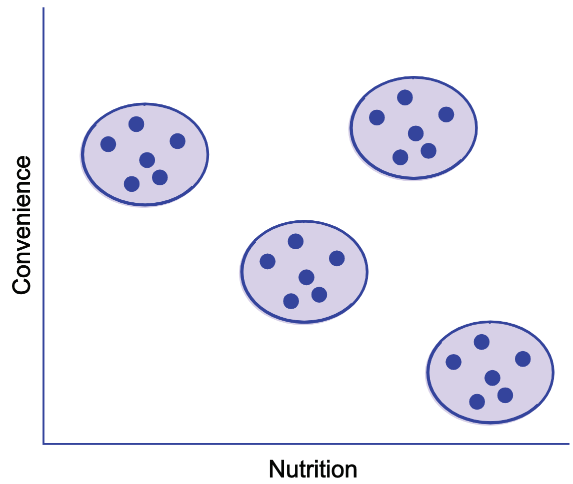


Fig 13.1(a) *Ideal Cluster Solution*

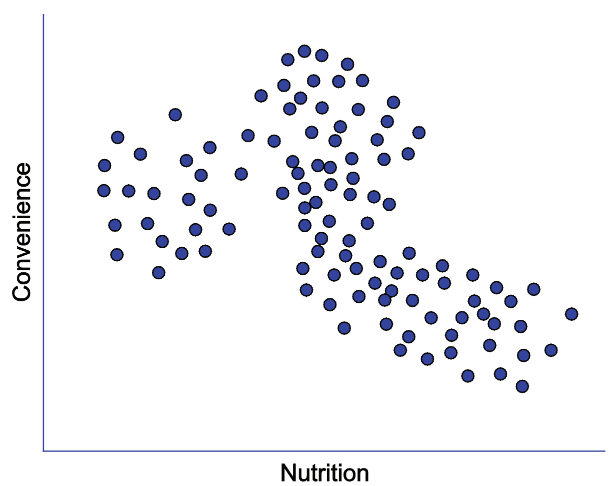


Fig 13.1(b) *Actual Cluster Solution*

However, the actual situation might be different as the person might be using different criteria for a weekday and for a weekend breakfast. Thus, as the criteria for decision-making become multiple, the grouping does not happen on a simple two-dimensional space but becomes multidimensional [Figure 13.1(b)]. Thus, the researcher is able to group people on these three dimensions and the point regarding the interpretation of benefits sought becomes clear as one understands the multidimensionality of needs. Thus, a bakery/confectionery shop selling sandwiches, patties, bread rolls as well as freshly ground idli batter, using the solution would know: (1) the lucrative segment, (2) the segment which might be motivated to buy if one takes care of their weekday/weekend needs, and (3) A segment which is currently not interested in getting a 'ready-to-eat' breakfast solution and might not look at the bakery as an outlet to visit in the morning. Once the homogenous clusters

NOTES

emerge, the next step is to determine the profile of the group in terms of who they are? What is their gender, age group, family size, etc.? What deals motivate them to buy from a particular store when they are buying eatables in general?

Differentiating Cluster Analysis

In terms of the nature of the technique vis-á-vis the other multivariate techniques, cluster analysis is similar in terms of analysing the function of multiple independent variables. However, there are essential differences between the other data reduction techniques and cluster analysis.

In factor analysis, the objective was to reduce the original correlated variables to a more manageable number of orthogonal or oblique factors. However, the data reduction was carried out on the columns of the data matrix. On the other hand, in cluster analysis the focus is on the rows, or the individuals or entities and the objective is to group the individuals on the variables.

The other data classification technique is the two group discriminant analyses. Here also, one might wish to group individuals or objects into groups, but the classification or identification of groups is *a priori*. Thus, in the technique one has an established classification rule and the objective of the technique is to validate the information to attest whether the groups obtained by the identified function are correctly classified or not. In cluster analysis, the whole population/sample is undifferentiated and the attempts to assess similarity in response to variables and the grouping happens *post* the clustering.

Usage of Cluster Analysis

Cluster analysis has widespread applicability in all the branches of social sciences and management. In management science, its most valuable contribution is in the area of marketing, especially market segmentation. Some applications of the technique are as follows:

- **Market segmentation:** As we know, Market segmentation is the process of splitting customers/potential customers, within a market into different groups/segments, where customers have the same/similar requirement satisfied by a distinct marketing mix (*McDonald and Dunbar*, 1998). This is one area that has seen maximum theorization on the basis of the outputs of the technique. Some examples are **ACORN** (A classification of residential neighbourhood based on 40 variables, e.g., house/car ownership, employment, religion, lifestyle, etc.), ***PRIZM*** (Potential rating index by zip market. This is based on 39 variables (for example, education, affluence, family life cycle, urbanization, race and ethnicity, mobility, etc.). The solution provides 62 lifestyle categories. The advantage with the technique is that one can

NOTES

look at the combination of variables to predict consumer or potential consumer groups. The best example of clustered solutions are in the area of **benefit segmentation** (*Haley*, 1968). Here, the consumers are divided into groups based on the benefits they seek from the product category. These, then, could be across age groups, gender and other variables. Thus, a marketer could design his product on the basis of this segmentation approach. Yankelovich (1964) segmented consumers in terms of 'what they look for in a watch' and classified people into those who are *price driven, durability* and *quality driven*, and those driven by *occasion-bound symbolism.* Sinha (2003) classified food shoppers into *fun* and *work shoppers* based on the benefits they seek from grocery/food purchase. Sondhi and Singhvi (2005) classified grocery shoppers *into transition shoppers, traditional shoppers, thrifty shoppers* and *indifferent shoppers*.

- **Segmenting industries/sectors:** The researcher could also go about grouping products or sectors (e.g., health or education) into blocks that have some common trait(s). This makes it easier for both the organizations and policy-makers while planning or evaluating the performance of the group.
- **Segmenting markets:** Cities or regions with some common traits like population mix, infrastructure development, climatic or socio-economic conditions could be clustered together. If one city in Kerala and another in Andhra Pradesh are in one cluster, then the organization is able to plan and execute a similar business approach in the two areas.
- **Career planning and training analysis:** In the area of human resources (HR) the technique can be used to group people into clusters on the basis of their educational qualification, experience, aptitude and aspirations. This grouping can assist the HR division to effectively manage training and manpower development for the members of different clusters effectively.
- **Segmenting financial sectors/instruments:** This is an emerging area where different factors like raw material cost, financial allocations, seasonality and other factors are being used to group sectors together to understand the growth and performance of a group of industries. This also assists the policy-makers and the financial analysts in assessing the monetary implications. A number of researchers are making use of clustering principles to group consumers and their investment behaviour on the basis of the combination of different variables and benefits sought (behavioural finance).

The basic premise of the above technique is, as we said earlier, wherever a researcher wants to manage the data (especially individual or organizational)

and he/she perceives that there could be multiple factors involved, cluster analysis is the best classification technique at his/her disposal.

Statistics Associated With Cluster Analysis

NOTES

Before we review the statistics involved with the technique, it is essential once again to examine the simplicity of the technique. Unlike the other multivariate techniques that we have discussed till now, cluster analysis is the simplest in terms of mathematical derivations. The simplest way to explain the technique is to understand that it simply measures the distance between objects on the basis of multiple variables and looks for similarity as a function of distance, i.e., the shorter the distance between two objects, the more similar they are.

Metric data analysis: For obtaining a cluster solution to data that is collected on an interval or ratio scale the statistical assessment of the distance between two objects can be done by calculating the Euclidean distance between them. In case the study has two variables (as stated in the earlier example of nutrition and ease of preparation) then the distance between person A and B can be calculated:

$$d_{A,B} = \sqrt{(X_{B1} - X_{A1})^2 + (X_{B2} - X_{A2})^2}$$

where X_{B1} represents the coordinate of person B on nutrition (interval scale data).

A note of caution here: The Euclidean distance is not 'scale invariant'. It may happen that the relative ordering of the objects in terms of their similarity can be affected by a simple change in the scale by which one or more of the variables are measured. Thus, it is advisable that the data is standardized before being subjected to any analysis. However, it may sometimes happen that standardization can reduce the differences between the groups on the variables that may well be the best discriminators of group differences. Thus, care needs to be taken initially in questionnaire designing to keep the variables measurement scales as roughly of more or less than the same range and avoid standardizing them. Only if the variables are measured on widely different units, standardization is needed to prevent the variables measured in larger units from dominating the cluster solution.

In the example, the two variables were placed on a 10-point scale of importance (with 1 = very important and10 = very unimportant). The values selected by person A and B were as follows:

Person	Nutrition	Ease of preparation
A	1	2
B	5	2

Then the distance between the two is,

$$d_{A,B} = \sqrt{(5-1)^2 + (2-2)^2} = 4.0$$

NOTES

Suppose there was a third person C who had selected

Person	Nutrition	Ease of preparation
C	6	2

Then the distance between A and C would be 5.0 and between B and C would be 1.0.

Thus, B and C are the most similar pair as the inter-person distance is the least and, as stated earlier, the shorter the distance, the greater the similarity.

If, in addition to having nutrition and ease of preparation for breakfast, we also had a variable that measured cost, we would effectively have a 3-dimensional solution. Then the formula would have been:

And generally, for any two objects, i and j:

$$d_{A,B} = \sqrt{(X_{B1} - X_{A1})^2 + (X_{B2} - X_{A2})^2 + (X_{B3} - {}_{A3})^2}$$

where,

$$d_{ij} = \sqrt{\sum_{k=1} (X_{ik} - X_{jk})^2}$$

d_{ij} = Distance between person i and j

k = Variable (interval/ratio)

i = Object/person

j = Object/person

Also, there are other distance measures available like the city-block or *Manhattan distance* between two objects, which is the sum of the absolute differences in the values for each variable. Another distance measure is the *Chebychev distance* between two objects, which is the maximum absolute difference in values for any variable. However, the most commonly used measure is the squared Euclidean distance. A point to be noted here is that clustering with squared Euclidean distance is faster than the regular Euclidean distance. Thus, for the purpose of clustering, we make use of squared Euclidean distance. The equation for this is the same as the Euclidean distance; only the square root is not calculated.

Then, based on the distance calculated, a distance matrix is created and clusters are created by moving from the most to the least similar pair based on a clustering method.

13.3.3 Multidimensional Scaling (MDS)

The underlying presumptions that one makes while creating an MDS are:

- The individual tries to group objects together.
- The grouped objects are usually evaluated and compared with each other so that they can coexist on a spatial map.

NOTES

- The basis of evaluation is not unidimensional and the user is at all times (consciously or unconsciously) using an underlying multidimensional space to evaluate the objects.

MDS essentially visually plots the perceptions and preferences of individuals singly and as a group, regarding a group of objects, individuals or both; even when the information about the dimensions or bases of evaluations is minimal.

Thus, the technique uses powerful mathematical tools in order to condense the data by creating visual representations based on the similarities or dissimilarities of data on a spatial map (Schiffman, *et al*. 1981). The map dimensions are hypothesized to be the attributes or features that the person uses to form certain impressions about the object. One of the most widely used mathematical methods to create the maps is based on Kruskal's (1964) stress calculations (to be discussed further in the chapter).

MDS usually involves a comparison of sorts to create a relative position of the considered objects. The comparison could be made on *defined dimensions*, or the apparent basis of comparison. However, more often than not, people make use of their own peculiar and sometimes subjective or *perceived dimensions* to make the comparison. For example, it could be the trust or faith in the service provider in handling the insured person's problems effectively. Thus, two objects or brands with the same defined dimensions might be perceived very differently by the person because:

- The evaluations might not be solely based on defined or observed parameters.
- The subjective and the objective dimensions might be absolutely unrelated.

To simplify the process further, the technique presents the dependent variable (which might be a similarity or dissimilarity between the object or preferences) and then tries to figure out what were the underlying independents or antecedents that led to the obtained map. The advantage of this method is that the researcher's influence where he/she attempts to provide the dimensions of comparison gets minimized. The disadvantage, however, would be to clearly figure out the dimension the respondents might have used for the comparison.

Thus, the researcher needs to be fairly well versed with the probable parameters that a person might use for comparison. These perceived parameters might emerge from a qualitative analysis of the respondents' decision process or through the researcher's review of the secondary literature about the product. The inputs obtained would have to be objectively—without any element of personal bias—assessed to comprehend the defined or apparent and the hidden or subjective dimensions being used.

A simple explanation of the concept: To understand the concept of mapping the respondent's choices, let us look at a very simple example of a consumer who buys bread every day for his family breakfast. Now, we ask him which bread he buys. He tells us, 'Harvest Gold, Britannia and Perfect.' Next, we ask him the similarity between two bread brands, say, Harvest Gold and Britannia, on a 7-point scale, where 1 is very similar and 7 is very dissimilar. He says, the similarity is 1. What this means is that:

- If we were to take a mental model of his brain when he said this, the two brands would be very close to each other.
- Suppose we say that the consumer was thinking of price and availability when he was telling us this. Thus, the unconscious evaluation that he did was on the two dimensions of 'price' and 'brand'. So, these two brand are two points close to each other in this two-dimensional map.
- The two manufacturers have to understand that there is no brand loyalty from the customer, as he could very easily buy the competing brand as they are almost identical to each other in his 'mind'.

Now, suppose, we ask him if he has consumed Harvest Gold multi-grain bread, and he says, 'yes'. So we now ask him to tell us the similarity between Harvest Gold regular and Harvest Gold multi-grain bread on the same 7-point scale. His answer is 6. Now, what will happen if we use the same dimensions as in the above case? The brand is the same for both, thus using a two-dimensional map would not be wise as the consumer may be now looking at the health benefit or nutritional content in the breads also as a dimension. Thus this means:

- The bread brands now need a three-dimensional representation to represent their relative positioning in the consumers mind.
- Harvest Gold multi-grain need not worry about competition with the other two as the consumer who buys the multi-grain will not buy them as a substitute as they are very different from the bread they eat regularly.

MDS is only one of the wide array of statistical techniques available for obtaining the object map. The whole range of these methods grouped together is termed as perceptual mapping techniques.

Let us now briefly attempt to understand the underlying algorithms of MDS.

- The inputs obtained by the respondents could be in terms of objects, individuals, brands, corporations or countries.
- The comparison could be in terms of similarities/dissimilarities, e.g. how similar is Delhi to Mumbai on a 7-point scale ranging from the most dissimilar to the most similar; or preferences, e.g. out of the five

listed brands, indicate the one you prefer the most to the one that is least preferred.

- As you can observe, the respondent is NOT given any dimension to measure similarity or dissimilarity.
- The preferences could be based on ranked data.
- The respondent might be asked to conduct a paired comparison of the data.

13.3.4 Discriminant Analysis

Discriminant analysis is used to predict group membership. This technique is used to classify individuals/objects into one of the alternative groups on the basis of a set of predictor variables. The dependent variable in discriminant analysis is categorical and on a nominal scale, whereas the independent or predictor variables are either interval or ratio scale in nature. When there are two groups (categories) of dependent variable, we have two-group discriminant analysis and when there are more than two groups, it is a case of multiple discriminant analysis. In case of two-group discriminant analysis, there is one discriminant function, whereas in case of multiple discriminant analysis, the number of functions is one less than the number of groups.

Objectives and Uses of Discriminant Analysis

The objectives of discriminant analysis are the following:

- To find a linear combination of variables that discriminate between categories of dependent variable in the best possible manner.
- To find out which independent variables are relatively better in discriminating between groups.
- To determine the statistical significance of the discriminant function and whether any statistical difference exists among groups in terms of predictor variables.
- To develop the procedure for assigning new objects, firms or individuals whose profile but not the group identity are known to one of the two groups.
- To evaluate the accuracy of classification, i.e., the percentage of customers that it is able to classify correctly.

Discriminant analysis can be a very powerful technique of analysis in multiple situations. Some areas in which it is extensively used are as follows:

- **Scale construction:** Discriminant analysis is used to identify the variables/statements that are discriminating and on which people with diverse views will respond differently. For example, in case one wants to assess people who believe that corporate governance is the responsibility of policy-makers against those who think it needs

NOTES

to be self driven or individual centric, one may generate a number of statements and then conduct a pilot study and select only those statements on which the two groups differ significantly.

- **Segment discrimination:** Most business managers recognize that the population under consideration can never be totally homogeneous in composition. Therefore, to understand what the key variables are on which two or more groups differ from each other, this technique is extremely useful. Questions to which one may seek answers are as follows:
  - o What are the demographic variables on which potentially successful salesmen and potentially unsuccessful salesmen differ?
  - o What are the variables on which users/non-users of a product can be differentiated?
  - o What are the economic and psychographic variables on which price-sensitive and non-price sensitive customers be differentiated?
  - o What are the variables on which the buyers of local/national brand of a product be differentiated?
- **Perceptual mapping:** The technique is also used extensively to create attribute-based spatial maps of the respondent's mental positioning of brands. The advantage of the technique is that it can present brands or objects and the attributes on the same map. Therefore, the business manager can determine what attribute is the unique selling proposition (USP) of which brand and which are the attributes that are valued by the respondent but there is no brand that currently satisfies that need.

Discriminant Analysis Model

The mathematical form of the discriminant analysis model is:

$$Y = b_0 + b_1 X_1 + b_2 X_2 + b_3 X_3 + ... + b_K X_K$$

where, Y = Dependent variable

b_s = Coefficients of independent variables

X_s = Predictor or independent variables

It may be kept in mind that the dependent variable Y should be a categorized variable, whereas the independent variables X_s should be continuous. As the dependent variable is a categorized variable, it should be coded as 0, 1 or 1, 2 and 3, similar to the dummy variable coding.

The method of estimating bs is based on the principle that the ratio of between group sum of squares to within group sum of squares be maximized. This will make the groups differ as much as possible on the values of the discriminant function.

After having estimated the model, the bs coefficients (also called discriminant coefficient) are used to calculate Y, the discriminant score by substituting the values of X_s in the estimated discriminant model. For any new data point that we want to classify into one of the groups, a decision rule is formulated for this purpose to determine the cut-off score, which is usually the midpoint of the mean discriminant scores of the two groups in case of two-group discriminant analysis, provided the size of the samples in the two groups are same. The accuracy of classification is determined by using a classification matrix (also called confusion matrix).

The relative importance of the independent variables could be determined from the standardized discriminant function coefficient and the structure matrix. The difference between the standardized and unstandardized discriminant function is that in the un-standardized discriminant function we have a constant term, whereas in the standardized discriminant function, there is no constant term.

13.4 THE PROCESS OF INTERPRETATION OF TEST RESULTS

A lot of statistical information is available in today's global and economic environment, which can be used successfully only if decision-makers are able to not only understand but also interpret the information, and use it effectively.

The steps involved in statistical data analysis are:

Step 1— Defining the problem

To obtain correct data it is essential to define the problem accurately.

Step 2 — Collecting data

The next step is to design ways for data collection. You could collect data from the entire population, that is a set of all elements of interest in a study or you could collect from a sample of the population, that is, a subset of the population. It can be collected through observational or experimental studies or from existing sources. The data could either be cross-sectional, that is collected at the same or approximately the same point in time or time series, that is, collected over several time periods. Data could be qualitative, that is, labels or names used to identify an attribute of each element. Quantitative data, on the other hand, could be numeric data indicative of numbers or volumes.

Step 3— Analysing the data

The data collected can be analysed using exploratory methods or confirmatory methods. While exploratory techniques try to find out what the data is trying to say using simple maths or illustrations, confirmatory methods use ideas (from probability theory) to try an answer specific questions.

Step 4 — Reporting the results

The results of the analysis can be presented in the form of a graph, a table, a pie chart or a set of percentages, in case the sample is small. In case the analysis involves an entire population, the report will also have to be detailed.

13.4.1 Guidelines for Making Valid Interpretation

Validation is the process by which evidence is gathered to come up with a reliable and sound scientific basis to help interpret the results/scores as proposed by the test developer or user. Validation, starts with a framework that defines the scope and aspects (in the case of multi-dimensional scales) of the proposed interpretation. The framework also includes a rational justification that links the interpretation to the test.

The next step is to list a series of propositions to be fulfilled for the interpretation to be valid. The other option is to compile a list of issues that may adversely affect the validity of the interpretations. In either case evidence needs to be gathered through original or empirical research or through meta-analysis or review of existing literature, or logical analysis of the issues. This supports or questions the interpretation's propositions or threats to its validity. The focus is on quality, rather than quantity, of the evidence.

A single interpretation of any test may require many propositions to be true. Even a strong evidence supporting a single proposition will not lessen the need to support the other propositions.

Evidence to support (or question) the validity of an interpretation can be classified into one of the following categories based on:

1. Test content
2. Response processes
3. Internal structure
4. Relations to other variables
5. Consequences of testing

Methods to collect each type of evidence should only be used when they result in information that would either back or challenge the propositions needed to interpret. Each evidence is then absorbed into a validity argument, which may require the test to be revised, or the administration protocol of the test to be modified or the theories or concepts forming the base of the interpretations to be revised. If any of this is done in any way, a new validation process will require to collect evidence, which will support the revised or new version.

NOTES

Qualitative Research and Validity

In quantitative research validity refers to the following:

- Internal validity (dependent on the strength of the relation between cause and effect)
- External validity (indicating the possibility to generalize findings).

In qualitative research, validity is a rather complex issue and it is not possible to apply traditional standards easily. If the knowledge is subjective or if there is a single inaccessible truth, the validity criteria can only be very generic or/and subjective. Lincoln and Guba (1985) suggested empiricist criteria for qualitative research, as follows:

- Credibility or internal validity
- Transferability or external validity
- Dependability
- Confirmability

Later the concepts of authenticity and morality were brought in (Angen 2000).

Check Your Progress

1. List one assumption in the ANOVA technique.
2. What is factor analysis?
3. What is the first step of factor analysis?
4. What is validation?

13.5 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. One of the assumptions used in the ANOVA technique is that all the involved populations from where the samples are taken are normally distributed.
2. Factor analysis is a multivariate statistical technique in which there is no distinction between dependent and independent variables.
3. The first and the foremost step in factor analysis is to decide on how many factors are to be extracted from the given set of data.
4. Validation is the process by which evidence is gathered to come up with a reliable and sound scientific basis to help interpret the results/scores as proposed by the test developer or user.

NOTES

13.6 SUMMARY

- There are situations where assumptions cannot be made. In such situations, different statistical methods are used, which are known as non-parametric tests.
- The Mann-Whitney test is used to examine whether two samples have been drawn from populations with same locations (mean).
- The Kruskal-Wallis test is an extension of the Mann-Whitney U test discussed earlier. Both methods require that the scale of the measurement of a sample value should be at least ordinal.
- Factor analysis is a multivariate statistical technique in which there is no distinction between dependent and independent variables. In factor analysis, all variables under investigation are analysed together to extract the underlined factors.
- Cluster analysis is a grouping technique. The basic assumption underlying the technique is the fact that similarity is based on multiple variables, and the technique attempts to measure the proximity in terms of the study variables.
- Discriminant analysis is used to predict group membership. This technique is used to classify individuals/objects into one of the alternative groups on the basis of a set of predictor variables.
- The dependent variable in discriminant analysis is categorical and on a nominal scale, whereas the independent or predictor variables are either interval or ratio scale in nature.
- Validation, starts with a framework that defines the scope and aspects (in the case of multi-dimensional scales) of the proposed interpretation. The framework also includes a rational justification that links the interpretation to the test.

13.7 KEY WORDS

- **Factor Analysis:** It is a process in which the values of observed data are expressed as functions of a number of possible causes in order to find which are the most important.
- **Cluster Analysis:** It is the task of grouping a set of objects in such a way that objects in the same group are more similar to each other than to those in other groups
- **Perceptual Mapping:** It is a diagrammatic technique used by asset marketers that attempts to visually display the perceptions of customers or potential customers.

13.8 SELF ASSESSMENT QUESTIONS AND EXERCISES

NOTES

Short-Answer Questions

1. Discuss the Mann-Whitney test.
2. List the testing procedure of the Wilcoxon matched-pair signed rank test.
3. Write a short-note on the uses of factor analysis.
4. List the steps in statistical data analysis.

Long-Answer Questions

1. Illustrate the Kruskal-Wallis test.
2. Examine the factor analysis exercise in detail.
3. Describe the use of cluster analysis.
4. Explain the discriminant analysis model in detail.

13.9 FURTHER READINGS

Creswell, John W. 2002. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. London: Sage Publications Inc.

Booth, Wayne, Gregory G. Colomb and Joseph M. Williams. 1995. *The Craft of Research*. Chicago: University of Chicago Press.

Bryman, Alan and Emma Bell. 2015. *Business Research Methods.* 4th Edition. United Kingdom: Oxford University Press.

Gupta, S.L. and Hitesh Gupta. 2012. *Business Research Methods.* New Delhi: Tata McGraw Hill Education Private Limited.

UNIT 14 REPORT WRITING

NOTES

Structure

14.0 Introduction
14.1 Objectives
14.2 Role and Types of Research Reports
14.3 Steps Involved in Drafting Research Reports
14.4 Contents of Research Report
14.5 Report Writing: Principles, Features and Criteria
    14.5.1 Principles of a Good Report Writing
    14.5.2 Features of a Good Research Report
    14.5.3 Criteria for Evaluating Research Reports/Research Findings
14.6 Research Report: Language Flow and Grammatical Quality
    14.6.1 Clarity and Brevity of Expressions
    14.6.2 References and Annotations
14.7 Data Support and Diagrammatic Elucidation
14.8 Answers to Check Your Progress Questions
14.9 Summary
14.10 Key Words
14.11 Self Assessment Questions and Exercises
14.12 Further Readings

14.0 INTRODUCTION

In this unit, you will learn about the various aspects of research report writing. On completion of the research study and after obtaining the research results, the real skill of the researcher lies in analysing and interpreting the findings and linking them with the propositions formulated in the form of research hypotheses at the beginning of the study. The statistical or qualitative summary of results would be little more than numbers or conclusions unless the researcher is able to present the documented version (research report) of the research endeavour.

Thus, one cannot overemphasize the significance of a well-documented and structured research report. Just like all the other steps in the research process, this requires careful and sequential treatment. In this unit, we will be discussing in detail the documentation of the research study. The format and the steps might be moderately adjusted and altered based on the reader's requirement. Thus, it might be for an academic and theoretical purpose or might need to be clearly spelt and linked with the business manager's decision dilemma.

NOTES

14.1 OBJECTIVES

After going through this unit, you will be able to:

- Discuss the role and types of reports
- Identify the steps involved in drafting reports
- Describe the various contents of a research report
- Explain the principles, criteria and features of a good research report
- Discuss the methods to be followed in diagrammatic elucidation of data in research reports
- Analyse how clarity and brevity of expressions enhances the quality of research reports

14.2 ROLE AND TYPES OF RESEARCH REPORTS

Research reports are designed in order to convey and record the information that will be of practical use to the reader. It is organized into distinct units of specific and highly visible information. The role of research reports may be summarized as follows:

- The research report fulfils the historical task of serving as a concrete proof of the study that was undertaken. This serves the purpose of providing a framework for any work that can be conducted in the same or related areas.
- It is the complete detailed report of the research study undertaken by the researcher, thus it needs to be presented in a comprehensive and objective manner. This is a one-way communication of the researcher's study and analysis to the reader/manager, and thus needs to be all-inclusive and yet neutral in its reporting.
- For academic purpose, the recorded document presents a knowledge base on the topic under study and for the business manager seeking help in taking more informed decisions, the report provides the necessary guidance for taking appropriate action.
- As the report documents all the steps followed and the analysis carried out, it also serves to authenticate the quality of the work carried out and establishes the strength of the findings obtained.

Thus, effective recording and communicating of the results of the study becomes an extremely critical step of the research process. Based on the nature of the research study and the researcher's orientation, the report can take different forms.

Types of Research Reports

Research reports can be categorized on the following bases:

1. On the basis of size
2. On the basis of information
3. On the basis of representation

1. Classification on the basis of size

Based on the size of the report, it is possible to divide the report into brief reports and detailed reports.

- **Brief reports:** These kinds of reports are not formally structured and are generally short, sometimes not running more than four to five pages. The information provided has limited scope and is a prelude to the formal structured report that would subsequently follow. These reports could be designed in several ways.
  - o **Working papers or basic reports** are written for the purpose of recording the process carried out in terms of scope and framework of the study, the methodology followed and instrument designed. The results and findings would also be recorded here. However, the interpretation of the findings and study background might be missing, as the focus is more on the present study rather than past literature.
  - o **Survey reports** might or might not have an academic orientation. The focus here is to present findings in easy-to-comprehend format that includes figures and tables. The advantage of these reports is that they are simple and easy to understand and present the findings in a clear and usable format.
- **Detailed reports:** These are more formal and could be academic, technical or business reports.

Sometimes, the researcher may prepare both kinds— for an individual as well as for a business purpose.

2. Classification on the basis of information

The ways through which the results of the research report can be presented on the basis of information contained as follows:

- **Technical report**: A technical report is not written by the researcher himself but is written on behalf of other researchers. In writing technical reports, importance is mainly given to the methods that have been used to collect the information and the data, the presumptions that were made and finally, the various presentation techniques that were used

NOTES

to present the findings and the data. Following are the main features of a technical report:

- o **Summary**: It covers a brief analysis of the findings of the research in a few pages.
- o **Nature**: It contains the reasons for which the research is undertaken, the analysis and the data that is required in order to prepare the report.
- o **Methods employed**: It contains a description of the methods that were employed in order to collect data.
- o **Data**: It covers a brief analysis of the various sources from which the data was collected with their features and drawbacks.
- o **Analysis of data and presentation of the findings**: It contains the various forms in which the data that has been analysed and can be presented.
- o **Conclusions**: It contains a brief explanation of the findings of the research.
- o **Bibliography**: It contains a detailed analysis of the various bibliographies that have been used in order to conduct the research.
- o **Technical appendices**: It contains the appendices for the technical matters and for questionnaires and mathematical derivations.
- o **Index**: The index of the technical report must be provided at the end of the report.

- **Popular report**: A popular report is formulated when there is a need to draw the conclusions of the findings of the research report. One of the main considerations that should be kept in mind while formulating a research report is that it must be simple and attractive. It must be written in a very simple manner that can be is understood all, and also be made attractive by using large prints, various sub-headings and by giving cartoons occasionally. The following are the main points that must be kept in mind while preparing a popular report:
  - o **Findings and their implications**: While preparing a popular report, importance is given to the findings of the information and the conclusions that can be drawn out of these findings.
  - o **Recommendations for action**: If there are any deviations in the report then recommendations are made for taking corrective action in order to rectify the errors.
  - o **Objective of the study**: In a popular report, the specific objective for which the research has been undertaken is presented.
  - o **Methods employed**: The report must contain the various methods that have been employed in order to conduct a research.

NOTES

- o **Results**: The results of the research findings must be presented in a suitable and appropriate manner by taking the help of charts and diagrams.
- o **Technical appendices**: The report must contain an in-depth information used to collect the data in the form of appendices.

- **Technical reports:** These are major documents and would include all elements of the basic report, as well as the interpretations and conclusions, as related to the obtained results. This would have a complete problem background and any additional past data/records that are essential for understanding and interpreting the study results. All sources of data, sampling plan, data collection instrument(s), data analysis outputs would be formally and sequentially documented.
- **Business reports:** These reports include conclusions as understood by the business manager. The tables, figures and numbers of the first report would now be pictorially shown as bar charts and graphs and the reporting tone would be more in business terms. Tabular data might be attached in the appendix.

3. Classification on the basis of representation

Following are the ways through which the results of the research report can be classified on the basis of representation:

- **Written report:** A written report plays a vital role in every business operation. The manner in which an organization writes business letters and business reports creates an impression about its standard. Therefore, the organization should emphasize on the improvement of writing skills of the employees in order to maintain effective relations with their customers. Making an effective written report requires a lot of hard work. Therefore, before you begin writing, it is important to know the objective, i.e., the purpose of writing, collection and organization of required data.
- **Oral report:** At times, oral presentation of the results that are drawn out of research is considered effective, particularly in cases where policy recommendations are to be made. This approach proves beneficial because it provides a medium of interaction between the listeners and the speakers. This leads to a better understanding of the findings and their implications. However, the main drawback of oral presentation is lack of any permanent records related to the research. Oral presentation of a report is more effective when it is supported by various visual devices such as slides, wall charts and white boards that help in better understanding of the research reports.

14.3 STEPS INVOLVED IN DRAFTING RESEARCH REPORTS

NOTES

Whatever the type of report, the reporting and dissemination of the study and its findings require a structured format and by and large, the process is standardized. As stated above, the major difference amongst the types of reports is that all the elements that essentially constitute a research report would be present only in a detailed technical report. In the management report, the information on the sampling techniques follows the research intention, and the questionnaire design details need not be reported. The review of past literature would be perfunctory in the management report; however, they would be detailed and accompanied with the bibliography in the technical report. Usage of theoretical and technical jargon would be higher in the technical report and visual presentation of data would be higher in the management report.

The process of report formulation and presentation is presented in Figure 14.1. As can be observed, the preliminary section includes the rudimentary parts, for example the title page, followed by the letter of authorization, acknowledgements, executive summary and the table of contents. Then come the background section, which includes the problem statement, introduction, study background, scope and objectives of the study and the review of literature (depends on the purpose). This is followed by the methodology section, which, as stated earlier, is again specific to the technical report. This is followed by the findings section and then come the conclusions. The technical report would have a detailed bibliography at the end.

In the management report, the sequencing of the report might be reversed to suit the needs of the decision-maker, as here the reader needs to review and absorb the findings. Thus, instead of simply summarizing the statistical results, the findings need to be presented in such a way that they can be used directly as inputs for decision-making. Thus, the last section would be presented immediately after the study objectives and a short reporting on methodology could be presented in the appendix.

Thus, the entire research project needs to be recorded either as a single written report or into several reports, depending on the need of the readers. The researcher would need to assist the business manager in deciphering the report, executing the findings, and in case of need, to revise the report to suit the specific actionable requirements of the manager.

Thus, research reports are the product of slow, painstaking, accurate inductive work. The usual steps involved in writing a research report are as follows:

NOTES

Step 1: Logical analysis of the subject-matter

Step 2: Preparation of the final outline

Step 3: Preparation of the rough draft

Step 4: Rewriting and polishing

Step 5: Preparation of the final bibliography

Step 6: Writing the final draft

14.4 CONTENTS OF RESEARCH REPORT

As presented in Figure 14.1, most research reports include the following sections:

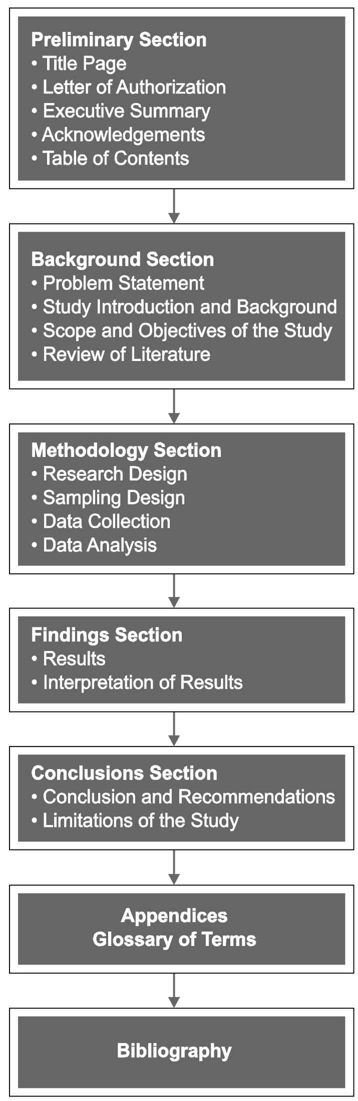


Fig. 14.1 *The Process of Report Formulation and Writing*

Preliminary section

This section mainly consists of identification information for the study conducted. It has the following individual elements:

NOTES

Title page: This includes classification data about:

- The target audience, or the intended reader of the report
- The report author(s), including their name, affiliation and address.
- The title of the study presented in a manner to clearly indicate the study variables; the relationship or status of the variables studied and the population to which the results apply. The title should be crisp and indicative of the nature of the project, as illustrated in the following examples.
    - o Comparative analysis of BPO workers and schoolteachers with reference to their work–life balance
    - o Segmentation analysis of luxury apartment buyers in the National Capital Region (NCR).
    - o An assessment of behavioural factors impacting consumer financial investment decisions.

Letter of transmittal: This is the letter that goes alongside the formalized copy of the final report. It broadly refers to the purpose behind the study. The tone in this note can be slightly informal and indicative of the rapport between the client-reader and the researcher. The letter broadly refers to three issues.It indicates the term of the study or objectives; next it goes on to broadly give an indication of the process carried out to conduct the study and the implications of the findings. The conclusions generally are indicative of the researcher's interest/learning from the study and in some cases may be laying the foundation for future research opportunities.

Letter of authorization: Sometimes the letter of authorization may be redundant as indications of the formal approval for conducting the study might be included in the letter of transmittal. The author of this letter is the business manager or corporate representative who formally gives the permission for executing the project. The tone of this letter, unlike the above document, is very precise and formal, leaving no room for speculation or interpretation.

As explained, this letter is not critical to submission, in case reference to the same has been made in the transmittal letter. However, in case it is to be included in the report, it is advisable to reproduce the exact prototype of the original letter.

Table of contents: All reports should have a section that clearly indicates the division of the report based on the formal areas of the study as indicated in the research structure. The major divisions and subdivisions of the study, along with their starting page numbers, should be presented. The subheadings

and the smaller sections of a topic need not be indicated here as then the presentation of the content seems cluttered.

NOTES

Once the major sections of the report are listed, the list of tables come next, followed by the list of figures and graphs, exhibits (if any) and finally the list of appendices.

Executive summary: This is the last and the most critical element of the preliminary section. The summary of the entire report, starting from the scope and objectives of the study to the methodology employed and the results obtained, have to be presented in a brief and concise manner. In case the research requirement was to provide recommended changes based on the findings, it is advisable to provide short pointers here. Interestingly, it has been observed that in most instances the business managers read only the executive summary in its complete detail and most often just glance through the rest of the report. Thus, it becomes extremely critical to present a Gestaltan view of the entire report in a suitable condensed form.

The executive summary essentially can be divided into four or five sections. It begins with the study background, scope and objectives of the study, followed by the execution, including the sample details and methodology of the study. Next comes the findings and results obtained. The fourth section covers the conclusions which are more or less based on the opinion of the researcher. Finally, as stated earlier, in case the study objectives necessitates implications, the last section would include recommendations and suggestions.

Acknowledgements: A small note acknowledging the contribution of the respondents, the corporates and the experts who provided inputs for accomplishing the study is to be included here.

Though the executive summary comes before the main body of the report, it is always prepared after the entire report has been finalized and is ready in its final form. The length of this section is one or two pages only and the researcher needs to effectively present the most significant parts of the study in a succinct form. It has been observed that the executive summary is a standalone document that is often circulated independently to the interested managers who might be directly or indirectly related to the study.

Main report

This is the most significant and academically robust part of the report. The sections of this division follow the essential pattern of a typical research study.

Problem definition: This section begins with the formal definition of the research problem. The problem statement is the research intention and is more or less similar to what was stated earlier as the title of the research study.

Study background: Study background presents details of the preliminary conceptualization of the management decision problem and all the groundwork done in terms of secondary data analysis, industry experts' perspectives and any other earlier reporting of similar approaches undertaken. Thus, essentially, the section begins by presenting the decision-makers' problem and then moves on to a description of the theoretical and contemporary market data that laid the foundation that guided the research.

In case the study is an academic research, there is a separate section devoted to the review of related literature, which presents a detailed reporting of work done on the same or related topic of interest.

Study scope and objectives: The logical arguments then conclude in the form of definite statements related to the purpose of the study. A clear definition of the scope and objective of the study is presented usually after the study background; in case the study is causal in nature, the formulated hypotheses are presented here as well.

Methodology of research: This section would not be sequentially placed here, for short reports or for a business report. In such reports, a short description of the methodology followed would be documented in the appendix. However, for a technical and academic report, this is a significant and primary contribution of the research study. The section would essentially have five to six sections specifying the details of how the research was conducted. These would essentially be:

- *Research framework or design*: The variables and concepts being investigated are clearly defined, with a clear reference to the relationship being studied. The justification for using a particular design has to be presented in a sequential and step-wise manner enlisting the experimental and control conditions, in case of a causal study. The researcher must take care to keep the technical details of the execution in the appendix and present the execution details in simple language, in the main body.
- *Sampling design:* The entire sampling plan in terms of the population being studied, along with the reasons for collecting the study-related information from the given group is given here. The execution details, in terms of sample size calculations, sampling frame considered and field work details can be recorded in the appendix rather than in the main body of the report. However, the sample profile and identification details are included in the main section. As stated earlier, the report needs to be reader-friendly, and too much technical information might not be required by the decision-maker.
- *Data collection methods:* In this section, the researcher should clearly list the information needed for the study as drawn from the study

NOTES

objectives stated earlier. The secondary data sources considered and the primary instrument designed for the specific study are discussed here. However, the final draft of the measuring instrument can be included in the appendix, which includes the execution details in terms of how the information was collected; how the open ended or opinion-based questions were handled; and how irregularities were handled and accounted for in the study. These and similar information enable a clear insight into the standardization of procedures maintained.

- *Data analysis:* Here, the researcher again needs to revisit the research objectives and the study design in order to justify the analytical tools and techniques used in the study. The assumptions and constraints of the analysis need to be explained here in simple, non-technical terms. There is no need to give a detailed description of the statistical calculations here.
- *Study results and findings:* This is the most critical chapter of the report and requires special care; it is probably also one of the longest chapters in the document. The researcher could, thus, consider either breaking this into subchapters or at least clear subheadings.

Researchers commonly divide the chapter on the basis of the data collection plan, i.e., there is a section on interview analysis, another one on focus group discussion and the third referring to the questionnaire analysis. This, however, does not serve any purpose as the results would then seem repetitive and disjointed. Instead, the result should be organized according to the information areas on which the data was collected or on the basis of the research objectives. There are also times when the data would be presented for the whole sample and then will be split and presented for the sub-population studied. For example, in the study on work-life balance, the findings were presented for the whole sample and then at the micro level for the BPO sector and separately for the school teacher segment. For each group, first the sample profile in terms of the demographic details of age, education, income (individual and family), years of experience, marital status, family size and other details was presented. Next, the descriptive data was made available on the seven sub-scales studied—and lastly—the predictive data–based on a multiple regression analysis with work-life balance as the dependent variable and the seven variables as independent, was presented. There was only one open-ended question related to the individual's suggestion as to what support was required from one's place of work to achieve work-life balance. This was presented last in the form of a bar chart showing variability in the responses given. Again as advised earlier, it is essential to present the findings in the form of simplified tables, graphs and figures, with the same being explained in simple text subsequently.

NOTES

Interpretations of results and suggested recommendations

The section study results and findings, i.e., the main report, presents a bird's eye view of the information as it exists in a summarized and numerical form. This kind of information might become difficult to understand and convert into actionable steps, thus the real skill of the researcher lies in simplifying the data in a reader-friendly language. Here, it is recommended that this section should be more analytical and opinion based. The results could be supported by the data that was presented earlier, for example, industry forecasts or the expert opinion. In case the report had an earlier section on literature review, the researcher could demonstrate the similarity of findings with past studies done on the topic. For example, in a study conducted on analysing the antecedents of turnover intention, the results obtained were explained as follows:

> *The results of the logit regression indicate that organizational commitment, age and martial status are significant at 5 per cent and 10 per cent levels respectively. The results indicate that as organizational commitment increases, the log of odd ratios in the favour of high turnover intention reduces, which is very logical. This is in accordance with the results obtained by Mobley, et al. (1978), Cotton and Tuttle (1986), Igbaria and Greenhaus (1992), Ahuja, et al. (2007). Thus, when employees feel committed to an organization, they are more likely to stay with the organization.*

Sometimes, the research results obtained may not be in the direction as found by earlier researchers. Here, the skill of the researcher in justifying the obtained direction is based on his/her individual opinion and expertise in the area of study. For example, in the same study on turnover intentions, contrary findings were explained as follows.

> *……..the results indicate that the log of odd ratios in favour of high turnover intention is more in the case of older respondents; this is contrary to the findings of Zeffane and Gul (1995) and Finegold, et al. (2002). However, this has to be understood in the light of the profession, as in India, most people take the BPO sector as a stop-gap career and use the time at the BPO employment as an opportunity to enhance their academic qualification and then move on, which is also one of the reasons why this sector is a young sector.*

Subsequent to the subsection on the interpretation of results, sometimes, the study requirement might be to formulate indicative recommendations to the decision-makers as well. Thus, in case the report includes recommendations, they should be realistic, workable and topically related to the industry studied. For example, to the business manager of organic food products, the following recommendation was made to build awareness amongst potential customers about the benefits of organic products:

NOTES

Organic food study: An illustration: The power of the print media in promoting a high-involvement product is unsurpassed. Thus, articles by leading nutritionists and doctors (88 per cent of consumers are influenced by others in consuming health alternatives) on any aspect of organic food would work well. The organic players need to take care that they do not advertise only their product offerings and price alone but they also need to educate the consumer on the health benefits of the products in their advertisements.

The article/advertisement could be placed in the Sunday supplements of newspapers so that people would read them at leisure. The major decision-makers for groceries are women thus magazines like Femina, Health and Savvy would be likely choices (the magazines suggested are English fortnightlies and have a reader profile similar to our sample profile). This is also because the product is a premium and niche product and thus requires selective exposure.

Limitations of the study

The last in this section is a brief discussion of the problems encountered during the study and the constraints in terms of time, financial or human resources. There could also have been constraints in obtaining the required information, either because the data about the topic of interest has not been collected or because it is not readily available to all. These clear revelations about the drawbacks are thus kept in mind by the reader when analysing the results and the implications of the study.

End notes

The final section of the report provides all the supportive material in the study. Some of the common details presented in this section are as follows:

Appendices: The appendix section follows the main body of the report and essentially consists of two kinds of information:

1. Secondary information like long articles or in case the study uses/is based on/refers to some technical information that needs to be understood by the reader. Or long tables or articles or legal or policy documents.
2. Primary data that can be compressed and presented in the main body of the report. This includes: Original questionnaire, discussion guides, formula used for the study, sample details, original data, long tables and graphs which can be described in statement form in the text.

Bibliography: This is an important part of the final section as it provides the complete details of the information sources and papers cited in a standardized format. It is recommended to follow the publication manuals from the American Psychological Association (APA) or the Harvard method of citation for preparing this section. In fact, with the advancement in computer technology the Microsoft office Word 2007 can automatically generate a

bibliography based on any of these formats, based on the source information provided in the document.

The reporting content of the bibliography could also be in terms of:

NOTES

- *Selected bibliography:* Selective references are cited in terms of relevance and reader requirement. Thus, the books or journals that are technical and not really needed to understand the study outcomes are not reported.
- *Complete bibliography:* All the items that have been referred to, even when not cited in the text, are given here.
- *Annotated bibliography:* Along with the complete details of the cited work, some brief information about the nature of information sought from the article is given. This could run into three or four lines or a brief paragraph.

At this juncture we would like to refer to another method of citation that an author might wish to use during report writing. This could be in the form of a footnote. To explain the difference we would first like to explain what a typical footnote is:

Footnote: A typical footnote, as the name indicates, is part of the main report and comes at the bottom of a page or at the end of the main text. This could refer to a source that the author has referred to or it may be an explanation of a particular concept referred to in the text.

The referencing protocol of a footnote and bibliography is different. In a footnote, one gives the first name of the person first and the surname next. However, this order is reversed in the bibliography. Here we start first with the surname and then the first name. In a bibliography, we generally mention the page numbers of the article or the total pages in the book. However, in a footnote, the specific page from which the information is cited is mentioned. A bibliography is generally arranged alphabetically depending on the author's name, but in the footnote the reporting is based on the sequence in which they occur in the text.

Glossary of terms: In case there are specific terms and technical jargon used in the report, the researcher should consider putting a glossary in the form of a word list of terms used in the study. This section is usually the last section of the report.

Check Your Progress

1. What are the various bases of categorizing research reports?
2. When is a popular report formulated?
3. List the usual steps involved in writing a research report.
4. What do you understand by the letter of transmittal?

14.5 REPORT WRITING: PRINCIPLES, FEATURES AND CRITERIA

NOTES

An important point to remember in report writing is that the document compiled is meant for specific readers. Thus, one needs to design the same according to the needs of the reader. Listed below are some features of a good research study that should be kept in mind while documenting and preparing the report.

Clear report mandate: While writing the research problem statement and study background, the writer needs to be focused, precise and very explicit in terms of the problem under study, the background that provided the impetus to conduct the research and the study domain. This is prepared on the assumption that the writer at no point in time needs to be physically present in order to clarify the research mandate. One cannot make an assumption that the reader has earlier insights into the problem situation. The writer needs to be absolutely clear on the need for lucidity of thought and dissemination of this knowledge to the reader.

Clearly designed methodology: Any research study has its unique orientation and scope and thus has a specific and customized research design, sampling and data collection plan. The writer, thus, needs to be explicit in terms of the logical justification for having used the study methods and techniques. However, as stated earlier, the language should be non-technical and reader friendly and any technical explanations or details must be provided in the appendix. In researches, that are not completely transparent on the set of procedures, one cannot be absolutely confident of the findings and resulting conclusions.

Clear representation of findings: The sample size for each analysis, any special conditions or data treatment must be clearly mentioned either as a footnote or as an endnote, so that the reader takes this into account while interpreting and understanding the study results. The sample base is very important in justifying a trend or taking a strategic decision; for example, if amongst a sample of bachelors we say that 100 per cent young bachelors want to buy grocery online or on the telephone and the recommended strategy is to suggest this as the delivery channel, one might be making an error if the size of the bachelors was four out of a total sample of 100 grocery buyers considered. Thus, complete honesty and transparency in stating the treatment and editing of missing or contrary data is extremely critical.

Representativeness of study finding: A good research report is also explicit in terms of extent and scope of the results obtained, and in terms of the applicability of findings. This is also dependent on whether the assumptions and preconditions made for formulating the conclusions and recommendations of the study have been explicitly stated.

NOTES

In order to ensure that one has been able to achieve the above stated objective, the reader must ensure a standardization of procedures in writing the document as well as follow standard protocols for preparing graphs and tables. In the following section we will briefly discuss some simple rules that the researcher can use as guidelines for this.

Guidelines for Effective Documentation

The guidelines for an effective documentation may be discussed under the following heads:

Command over the medium: Even though one may have done an extremely rigorous and significant research study, the fundamental test still remains as to how the learning has been disseminated. Regardless of how effective the graphs and figures are in showcasing the findings, the verbal description and explanation—in terms of why it was done, how it was done, and what was the outcome, still remain the acid test.

Thus, a correct and effective language of communication is critical in putting ideas and objectives in the vernacular of the reader/decision-maker. The writer may, thus, be advised to read professionally written reports and, if necessary, seek assistance from those proficient in preparing business reports.

Phrasing protocol: There is a debate about whether or not one makes use of personal pronoun while reporting. To understand this, one needs to revisit the responsibility of the researcher, which is to present the findings of his/her study, with complete objectivity and precision. The use of personal pronoun such as 'I think…..' or 'in my opinion…..' lends a subjectivity and personalization of judgement. Thus, the tone of the reporting should be neutral. For example:

> 'Given the nature of the forecasted growth and the opinion of the respondents, it is likely that the……'

Whenever the writer is reproducing the verbatim information from another document or comment of an expert or published source, it must be in inverted commas or italics and the author or source should be duly acknowledged. For example:

> Sarah Churchman, Head of Diversity, PricewaterhouseCoopers, states *'At PricewaterhouseCoopers we firmly believe that promoting work–life balance is a 'business-critical' issue and not simply the 'right thing to do'. Profitable growth and sustainable business depends on attracting and retaining top talent and we know, from our own research and experience that work–life policies are an essential ingredient of successful recruitment and retention strategies.'*

The writer should avoid long sentences and break up the information in clear chunks, so that the reader can process it with ease. Similar is the case in structuring of the chapters or sections of the report that can be logically

broken down into smaller sections that are comprehensive and complete and yet maintain a strong but logical link with the flow of reporting.

NOTES

With the onset of the use of abbreviated communications in SMS and emails, most people tend to use shortened form as 'cd.' for could and 'u' for you, etc. Also the use of colloquial language and slangs must be avoided, as this is a formal document and one must maintain the sanctity of the formal documentation required in a research report.

Simplicity of approach: Along with grammatically and structurally correct language, care must be taken to avoid technical jargon as far as possible. The business manager, might have been a business student who had prepared a research report in his academic pursuits but now understands simple common terms and does not have the time or inclination to juggle the dictionary and the report together. In case it is imperative to use certain terminology, then, as stated earlier, the definition of these terms can be provided in the glossary of terms at the end of the report.

Sometimes the writer may prepare different research reports for the same study to suit the need of diverse readers, for example, the business report needs to be crisp and simple with definable and workable recommendations. On the other hand, an academic report could discuss extensively the literature review section, as well as the statistical analysis and interpretation.

Report formatting and presentation: In terms of paper quality, page margins and font style and size, a professional standard should be maintained. The font style must be uniform throughout the report. The topics, subtopics, headings and subheadings must be construed in the same manner throughout the report. Sometimes certain academic reports have a mandated format for presentation which the writers need to follow, in which case there is no choice in presentation.

However, when this is not clear, it is advisable that the writer creates his/her own formatting rules and saves it on a notepad so that they can be implemented in a standardized and professional manner.

The researcher can provide data relief and variation by adequately supplementing the text with graphs and figures. Pictorial representations are simple to comprehend and also break the monotony and fatigue of reading. They should be used effectively whenever possible in the report.

14.5.1 Principles of a Good Report Writing

Based on the above description, it may be concluded that report writing should be based on the following principles:

- **Principle of purpose**: A report must have a clear and meaningful purpose that can be converted into an effective management. A clear statement of purpose helps prepare a well-focussed report on which the management can work. Specification of purpose is important because:

NOTES

- o Reports are analyses of facts and proposals.
- o They are records of particular business activities.

- **Principles of organization**: A written report should be well-designed and well-ordered. The managerial plan of a report must include the following:
  - o Purpose of the report
  - o Information required to be included in the report
  - o Method used to collect report data
  - o Summary of the report
  - o Problems and solutions of the subject mentioned in the report
  - o An appendix that describes and confirms the content and conclusion of the report
- **Principles of brevity**: Reports should be concise. It is essential because long reports:
  - o Are costly.
  - o Are difficult to examine.
  - o Are prone to disapproval, as they seem insufficient.
  - o Focus on irrelevant minor details that may lead to the ignorance of major points.
- **Principles of clarity**: Reports should be clear. Clarity can be maintained by using simple language for writing the report. New terms, if any in the report, should be properly explained to avoid confusion.
- **Principle of scheduling**: Reports should be prepared at that time when there is no undue burden on the staff or when the staff has sufficient time to prepare reports. However, the time period between the gathering of data and generating finished reports should not be long; otherwise, the report may become outdated and useless if it is not completed in time.
- **Principle of cost**: While preparing reports, it is necessary that their cost–benefit analysis should be done. A report should be minimum at costs and maximum at benefits. If the cost of preparation of the report is high but its benefit is low, then it is not advisable to prepare that report.

14.5.2 Features of a Good Research Report

Research reports must be absolutely efficient and well formatted and the matter should be clear, analytical and directive. The actual facts need to be explained clearly. Data and results should be furnished in graphical or tabular format as it would create a substantially good impression and would be unambiguous to understand.

NOTES

The characteristic features of a good research may be listed as follows:

- Information collected in the report should be relevant and focused to derive desired results.
- The report should strictly adhere to predefined goals and objectives.
- The report should provide the description of the questionnaires used in analysis and the means adopted in their preparation.
- The report should elaborate the methodology used in the interviews.
- There must be an executive summary of the work in the report.
- The report should not only present the actual analysis but also the reasons of making this report. It should also highlight the advantages and profit it can provide after successful implementation of business plans described inside the report.
- It should also mention the methodology of the research presenting the overall process adopted to create the report.
- The report needs to be flexible enough so that it may be changed according to requirements.

14.5.3 Criteria for Evaluating Research Reports/Research Findings

Research reports/findings are evaluated on the basis of following criteria:

- **Clarity:** The report should be clear in terms of representation of data. It should be easy to understand.
- **Statement of objective:** The objective of the report should be stated in the beginning of a report. While evaluating, it is important to check whether the research achieved the stated objective.
- **Relevance of data:** The data of the report should be relevant to the research topic. In addition, it is important to check whether the recent data was used in report.
- **Analysis of data:** The data should be properly analyzed. Thus, the evaluator checks whether all the findings are supported by analysis.
- **Unbiased:** The report should not be biased towards a particular interpretation because biasness affects the complete process of research.

14.6 RESEARCH REPORT: LANGUAGE FLOW AND GRAMMATICAL QUALITY

A report must have a clear and logical structure with clear indication of where the ideas are leading. It should be able to make a good first impression. The presentation of the report is very important. All reports must be written in a good language, using short sentences and correct grammar and spellings. The main points to be kept in mind in this light are as follows:

NOTES

- Context and style:
  - o Appropriate, informative title for the report
  - o Crisp, specific, unbiased writing with minimal jargon
  - o Adequate analysis of prior relevant research
- Questions/hypotheses:
  - o Clearly stated questions or hypotheses
  - o Thorough operational definitions of key concepts along with the exact wording or measurement of the key variables
- Research procedures:
  - o Full and clear description of the research design
  - o Demographic profile of the participants/subjects
  - o Specific data gathering procedures
- Data analysis:
  - o Appropriate inferential statistics for sample or experimental data and appropriate use of descriptive statistics
  - o Clear and reasonable interpretation of the statistical findings, accompanied by effective tables and figures
- Summary:
  - o Fair assessment of the implications and limitations of the findings
  - o Effective commentary on the overall implications of the findings for theory and/or policy

14.6.1 Clarity and Brevity of Expressions

There is a famous saying that 'words are like mirror that reflect the personality of the person from whose mouth they come out'. Thus, if a research wants to absorb the attention of the reader, then it must have clarity in its expression as this will also tell a lot about the clarity of the researcher's thought. Experts emphasize the importance of using as few words as possible to deliver your message. However, sometimes messages that are very brief sacrifice clarity and leave out vital information. Thus, while crafting his report, the researcher should choose clarity over brevity, and include all relevant information and be sure it is logically organized.

Three rules for bringing clarity in reports

In business writing, you get points for clarity, not style. Instead of trying to wax poetic about your division's plans for the next 60 days, just make your point. Here are three ways to do that:

NOTES

(i) **Limit one idea to one paragraph**: The researcher should limit his thoughts to one per paragraph. When he has another suggestion, thought or idea, he should start a new paragraph.

(ii) **Make it scannable:** The report should be so prepared that audience is able quickly scan the researcher's message and understand his point.

(iii) **Put your point in the first sentence**. The researcher should not entice his readers with background information and build-up. He should make his primary point first. Then he should go into supporting detail.

14.6.2 References and Annotations

Several report types like scientific, engineering, technical and census reports contain either original writing or text adopted from a previous work. As such, a report writer should be careful and should avoid any violation of copyright laws and plagiarism. The necessary rule of thumb in this regard can be stated as follows:

- **Citations and referencing**:
  - o A **citation** is the acknowledgement in your writing of the work of other authors and includes paraphrasing and making direct quotes.
  - o Unless citation is very necessary, you should write the material in your own words. This shows that you understand what you have read and know how to apply it, to your own context.
  - o Direct quotes should be used sparingly.
- **Direct quotes**:
  - o **Short direct quotes**: These need to be placed between quotation marks. For example, Rosenfield defines a cluster as a 'geographically bounded concentration of similar, related or complementary businesses, with active channels for business transactions, communications and dialogue that share specialized infrastructure, common opportunities and threats.' This shows clearly that the words being used are not your own words.
  - o **Long direct quotes**: There are occasions when it is useful to include long direct quotes. If you are quoting more than forty words, you should again use quotation marks but also indent the text. For example:

The sustainability of higher value-added industry is grounded in the diminishing significance of cost structures. At the level of the European Union, a weak capacity to innovate has been identified as an innovation, in the sense of product, process and organizational innovation, accounts for a very large amount, perhaps 80–90 per cent of the growth in productivity in advanced economies.

14.7 DATA SUPPORT AND DIAGRAMMATIC ELUCIDATION

NOTES

The visual representation of the findings in the form of lines or boxes and bars relative to a number line is easy to comprehend and interpret. There are some standard rules and procedures available to the researcher for this; also there are computer programs like MS Excel and SPSS, where the numbered data can be converted with ease into graphical form.

Line and curve graphs: Usually, when the objective is to demonstrate trends and some sort of pattern in the data, a line chart is the best option available to the researcher as the line is able to clearly portray any change in pattern during a particular time period. On the same chart, it is also possible to show patterns of growth of different sectors or industries in the same time period or to compare the change in the studied variable across different organizations or brands in the same industry. Certain points to be kept in mind while formulating line charts include:

- The time units or the causal variable being studied are to be put on the X-axis, or the horizontal axis.
- If the intention is to compare different series on the same chart, the lines should be of different colours or forms (Figure 14.2).
- Too many lines are not advisable on the same chart as then the data becomes too cluttered; an ideal number would be five or less than five lines on the chart.

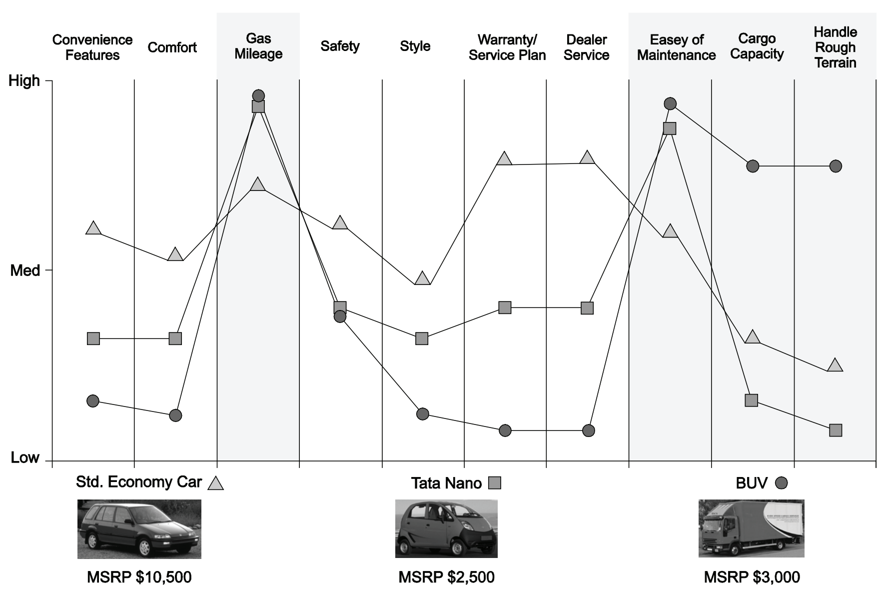


***Fig. 14.2** Comparative Analysis of Vehicles (including Nano) on Features Desired by Consumers*

Source: *vytrak.com*

NOTES

- The researcher also must take care to formulate the zero baseline in the chart as other-wise, the data would seem to be misleading. For example, in Figure 14.3(a), in case the zero baseline is (as shown in the chart) the expected change in the number of hearing aids units to be sold over the time period 2002–03 to 2007–08, it can be accurately perceived. However, in Figure 14.3(b), where the zero is at 1,50,000 units, the rate of growth can be misjudged to be more swift.

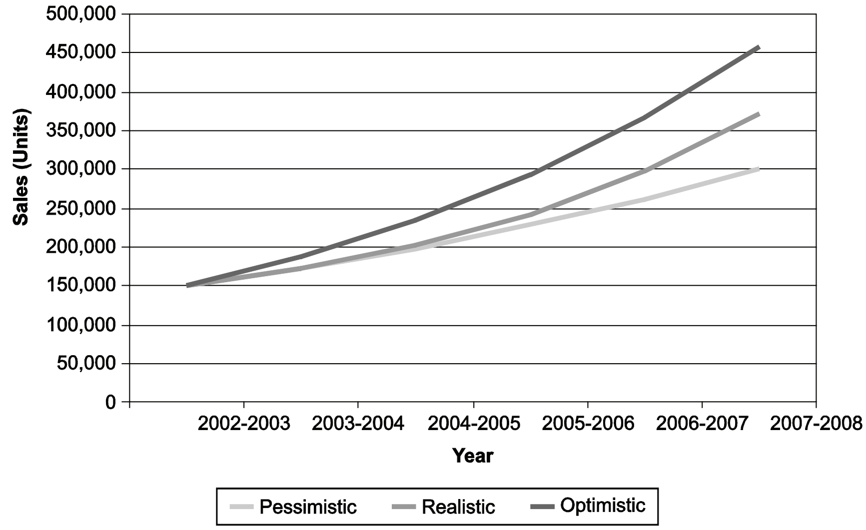


Fig. 14.3(a) *Expected Growth in the Number of Hearing Aids Units to be sold in North India (Three Perspectives)*

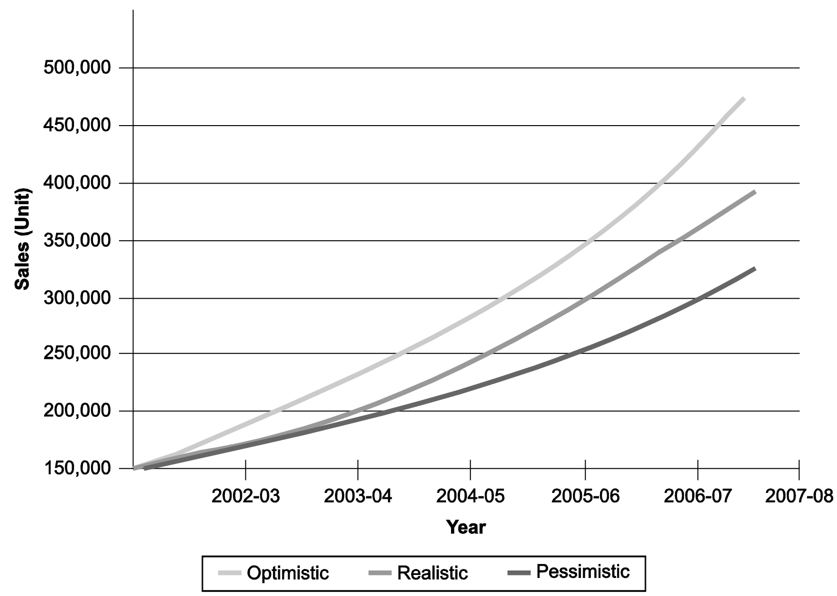


Fig. 14.3(b) *Expected Growth in the Number of Hearing Aids Units to be sold in North India (Three Perspectives)*

NOTES

Area or stratum charts: Area charts are like the line charts, usually used to demonstrate changes in a pattern over a period of time. However, here there are multiple lines that are essentially components of the original composite data. What is done is that the change in each of the components is individually shown on the same chart and each of them is stacked one on top of the other. The areas between the various lines indicate the scale or volume of the relevant factors/categories (Figure 14.4).

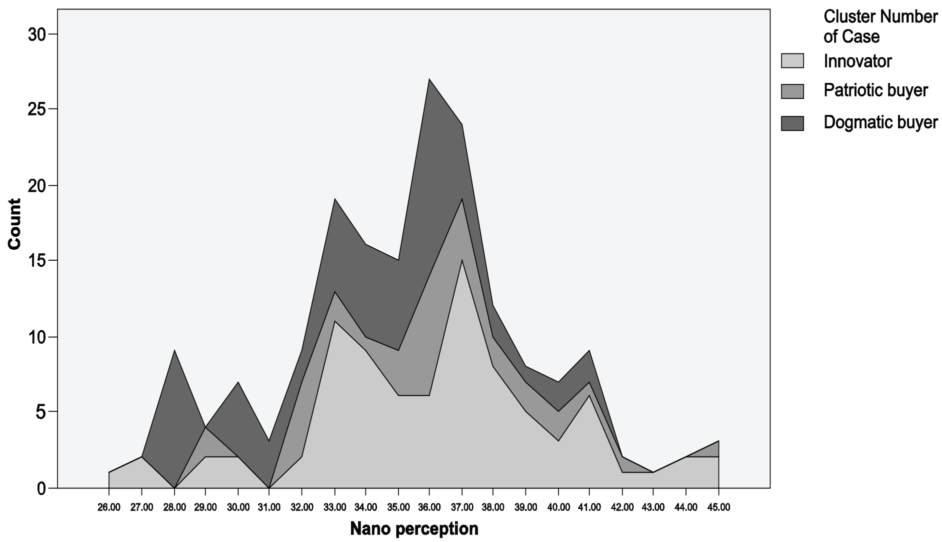


Fig. 14.4 *Perception of Nano by Three Psychographic Segments of Two-wheeler Owners*

Pie charts: Another way of demonstrating the area or stratum or sectional representation is through the pie charts. The critical difference between a line and pie chart is that the pie chart cannot show changes over time. It simply shows the cross-section of a single time period**.** The sections or slices of the pie indicate the ratio of that section to the total area of the parameter being displayed. There are certain rules that the researcher should keep in mind while creating pie charts.

- The complete data must be shown as a 100 per cent area of the subject being graphed.
- It is a good idea to have the percentages displayed within or above the pie rather than in the legend as then it is easier to understand the magnitude of the section in comparison to the total. For example, Figure 14.5 shows the brand-wise sales in units for the existing brands of hearing aids in the North Indian market.

NOTES

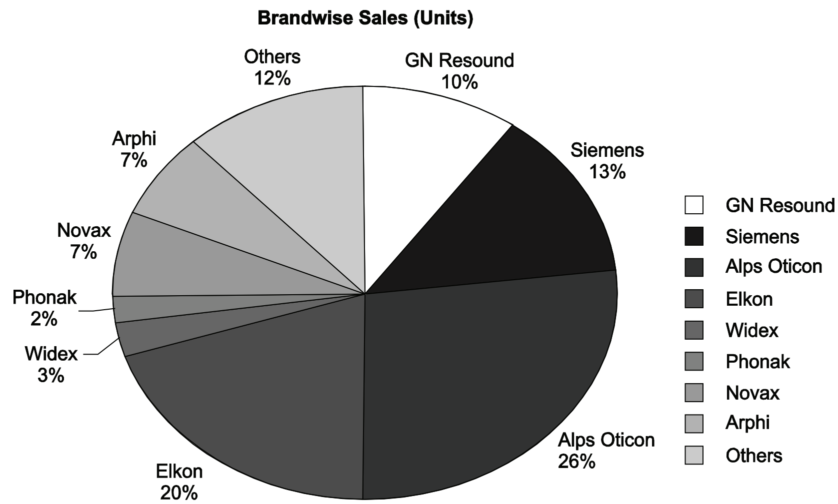


Fig. 14.5 Brandwise Sales (units) of Hearing aids in the North India Market (2002–03)

- Showing changes over time is difficult through a pie chart, as stated earlier. However, the change in the components at different time periods could be demonstrated as in Figure 14.6, showing share of the car market in India in 2009 and the expected market composition of 2015.

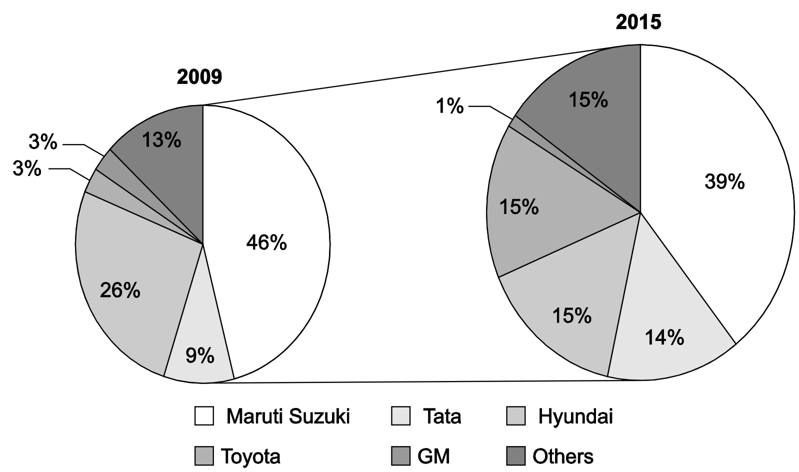


Fig. 14.6 Current Structure of the Indian car Market (2009) and the Forecasted Structure for 2015

Bar charts and histograms: A very useful representation of quantum or magnitude of different objects on the same parameter are bar diagrams. The comparative position of objects becomes very clear. The usual practice is to formulate vertical bars; however, it is possible to use horizontal bars as well if none of the variable is time related [Figure 14.7(a)]. Horizontal bars are especially useful when one is showing both positive and negative patterns on the same graph [Figure 14.7(b)]. These are called bilateral bar charts and are especially useful to highlight the objects or sectors showing a varied pattern

on the studied parameter. It is possible to generate bar graphs with relative ease with computer programs today and the distance between the bars can be extremely precise as compared to those created by hand.

NOTES

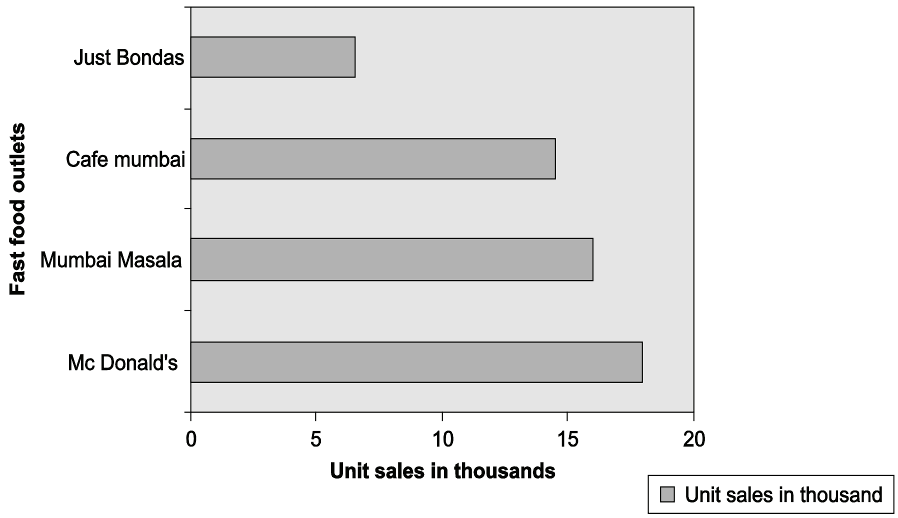


Fig. 14.7(a) Bar Chart per Day, Unit Sales (Thousands) at Fast Food Outlets in Mumbai

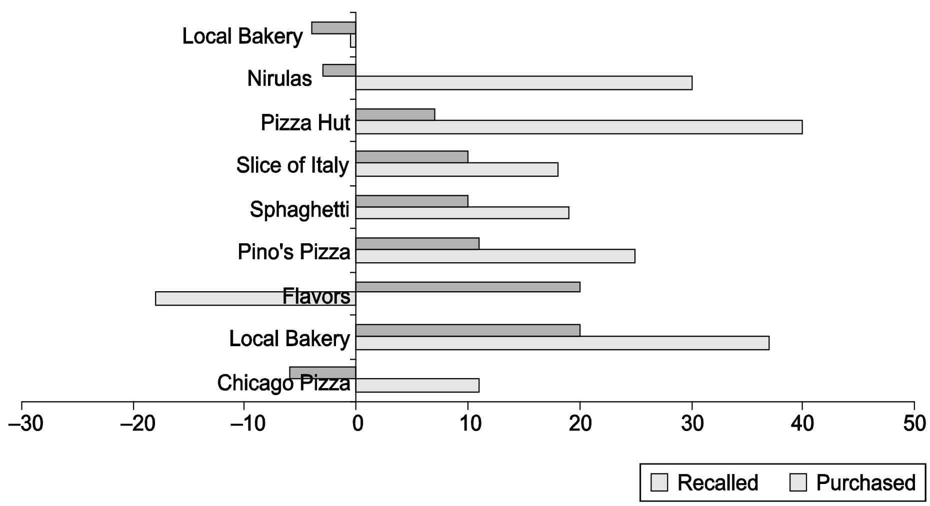


Fig. 14.7(b) Bilateral Bar Chart—the Brand Recall and Brand Purchase Response for Pizza Joints in the NCR

Another variation of the bar chart is the histogram (Figure 14.8) here the bars are vertical and the height of each bar reflects the relative or cumulative frequency of that particular variable.

NOTES

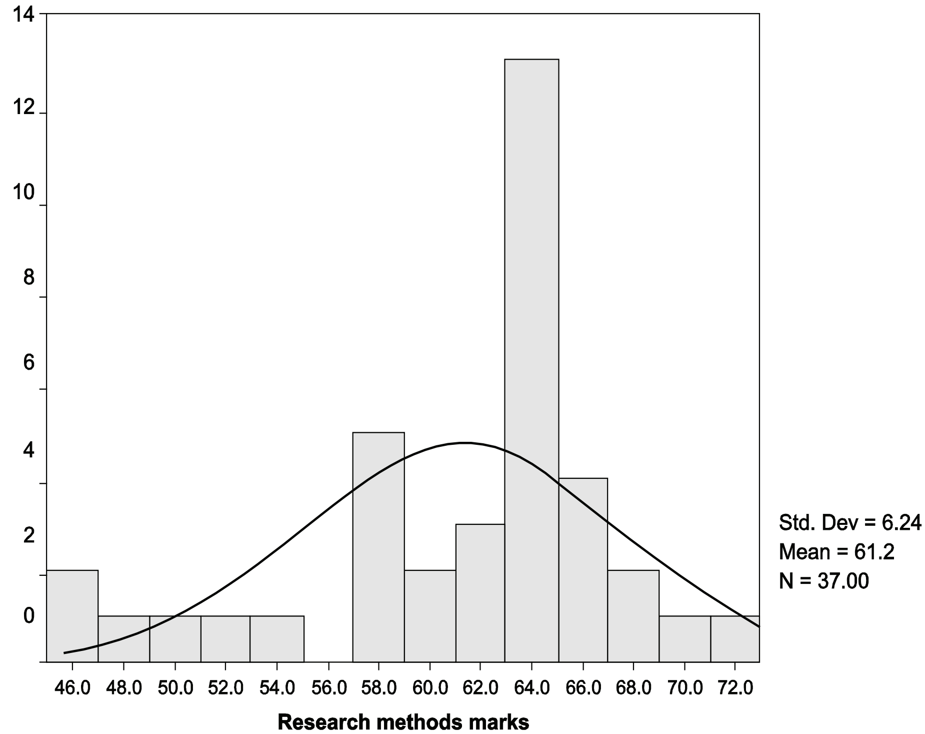


Fig. 14.8 *Histogram (with Normal Curve) Displaying Marks in a Course on Research Methods for Management*

Pictogram: A pictogram shows graphical representation of data. Pictograms are most often used in popular and general read such as in magazines and newspapers, as they are eye-catching and easy to comprehend by one and all. They are not a very accurate or scientific representation of the actual data and, thus, should be used with caution in an academic or technical report.

Geographic representation: Geographic or regional maps related to countries, states, districts, territories can be used as a base to show occurrence of the studied variable in various regions or to show comparative analysis about major brands or industries or minerals. In case of comparative data, the researcher must provide the legend in the displayed map.

Check Your Progress

5. Why does a report need a clear statement of purpose?
6. When should line charts be used?
7. What is the difference between a line and pie chart?
8. What is a pictogram?

14.8 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

NOTES

1. Research reports can be categorized on the following bases:
    - On the basis of size
    - On the basis of information
    - On the basis of representation
2. A popular report is formulated when there is a need to draw the conclusions of the findings of the research report. One of the main considerations to be kept in mind while formulating a research report is that it must be simple and attractive.
3. The usual steps involved in writing a research report are as follows:
    - Logical analysis of the subject-matter
    - Preparation of the final outline
    - Preparation of the rough draft
    - Rewriting and polishing
    - Preparation of the final bibliography
    - Writing the final draft
4. The letter of transmittal is the letter that goes alongside the formalized copy of the final report. It broadly refers to the purpose behind the study. The tone in this note can be slightly informal and indicative of the rapport between the client-reader and the researcher.
5. A report must have a clear and meaningful purpose that can be converted into an effective management. A clear statement of purpose helps prepare a well-focussed report on which the management can work.
6. When the objective is to demonstrate trends and some sort of pattern in the data, a line chart is the best option available to the researcher as the line is able to clearly portray any change in pattern during a particular time period.
7. The critical difference between a line and pie chart is that the pie chart cannot show changes over time. It simply shows the cross-section of a single time period.
8. A pictogram shows graphical representation of data. Pictograms are most often used in popular and general read such as in magazines and newspapers, as they are eye-catching and easy to comprehend by one and all.

14.9 SUMMARY

NOTES

- Once a research project reaches its conclusion, the most important task ahead of the researcher is to document the entire work done in the form of a well-structured research report.
- There are brief reports which, as the name suggests, are of a shorter length and could be in the form of working papers or short survey reports. These might be expanded while preparing the detailed report.
- The detailed report may vary in scope and style depending on the requirement of the reader for whom it is to be created. These could be in the form of highly structured and comprehensive technical reports or simpler action-oriented business reports.
- No matter what the orientation is, reports generally follow a standardized structure. The entire report can be divided into three main sections—the preliminary section, the main body and endnotes.
- The preliminary section typically includes the title page, the table of contents and the letter of authorization and the letter of transmittal. The most significant section of this part is a short but succinct executive summary, which summarizes the main report.
- The main report includes the background of the study, as well as the scope, framework and the methodology of the study, including the data collection and sampling plan. The section culminates into the most important part of the report, the study findings and interpretation of these results.
- The last section of the report includes the bibliography and all the supportive documents like measuring instrument (questionnaire), the sample details and any relevant document that needs to be referred to comprehend the report.
- Any well documented report must be clear and explicit in its reporting. There must be no ambiguity in either presenting the findings or representativeness of the findings. The designed report must be formulated, keeping the reader and the researcher's capabilities in mind.
- The author must follow a widely mandated and followed protocol for reporting and referencing in the report. The reporting needs to be objective and simple rather than complex and opinionated.
- The researcher at times might need to verbally present the research study. These presentation sessions need to be brief and crisp, with the thrust being more on the methodology and findings.

- Communicating and presenting the research results is both a skill and an art and the richness of the research findings needs to be appropriately shared with the interested listeners in a manner best suited to their individual needs.

14.7 KEY WORDS

- **Technical Reports:** These are major documents and would include all elements of the basic report, as well as the interpretations and conclusions, as related to the obtained results.
- **Business Reports:** These reports include conclusions as understood by the business manager.
- **Letter of Transmittal:** This is the letter that goes alongside the formalized copy of the final report. It broadly refers to the purpose behind the study.
- **Bibliography:** This is an important part of the final section as it provides the complete details of the information sources and papers cited in a standardized format.
- **Footnote:** A typical footnote, as the name indicates, is part of the main report and comes at the bottom of a page or at the end of the main text.
- **Citation:** It is the acknowledgement in your writing of the work of other authors and includes paraphrasing and making direct quotes.

14.8 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. What are the different bases of classifying research reports?
2. State the various principles on which a good research report is based.
3. Identify the various criteria of evaluating research reports/findings.
4. What are the rules for presenting references and annotations in a research report?
5. What is geographic representation?

Long-Answer Questions

1. Discuss in detail the steps that a researcher needs to follow to formulate a good research report. Do the criteria become different for different kinds of reports? Explain with examples.

NOTES

2. What should be the ideal structure of a research report? What are the elements of the structure defined by you?
3. What are the guidelines for effective report writing? Illustrate with suitable examples.
4. 'Visual representations of results are best understood by a reader, thus special care must be taken for this formulation.' Examine the truth of this statement by giving suitable examples.
5. What are the guidelines a researcher must follow for graphical and tabular representation of the research results? Discuss.

14.9 FURTHER READINGS

Creswell, John W. 2002. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. London: Sage Publications Inc.

Booth, Wayne, Gregory G. Colomb and Joseph M. Williams. 1995. *The Craft of Research*. Chicago: University of Chicago Press.

Bryman, Alan and Emma Bell. 2015. *Business Research Methods.* 4th Edition. United Kingdom: Oxford University Press.

Gupta, S.L. and Hitesh Gupta. 2012. *Business Research Methods.* New Delhi: Tata McGraw Hill Education Private Limited.